77745

FMCSA-97-2350-954

Preliminary Regulatory Evaluation and Regulatory Flexibility Act Analysis Hours of Service NPRM

Federal Motor Carrier Safety Administration
April 2000

Executive Summary

The Federal regulations governing the number of hours commercial motor vehicle (CMV) drivers may drive their vehicles have remained substantially unchanged for six decades. The Federal Motor Carrier Safety Administration (FMCSA) is considering revising these regulations to take advantage of improved understanding of the physiology of sleep and its relationship to human alertness. Because of the potentially large safety and economic impacts of the options under consideration, the FMCSA has completed this Regulatory Evaluation.

The FMCSA examined 5 options. Under option 1, drivers would have to be off-duty for at least 12 consecutive hours, and could be on-duty the remaining 12 hours. There would be no distinction between on-duty driving time and on-duty non-driving time. Drivers would be encouraged to begin work at approximately the same time each day, and would be required to have at least 58 consecutive hours off-duty per work week.

Under option 2, most drivers would face the same requirements as under proposal 1. Long-haul and regional drivers could work and drive up to 12 hours, and would need a minimum of 10 consecutive hours off-duty. The 2 additional off-duty hours could be taken during the on-duty period or added to the consecutive off-duty period Long-haul and regional drivers would also be allowed to use a two week schedule for determining "weekend" off-duty time, with one long and one short weekend. Work-truck and bus drivers would need a minimum of 11 hours off-duty, 9 of which must be consecutive. These drivers must stop driving within 15 hours of starting work, and could only drive 5 hours per day. They would be limited to 25 hours of driving per week.

Option 3 is the same as proposal 2, with the added provision that drivers would not be allowed to drive between the hours of midnight and 6 AM more than 18 hours per week. Option 4 is the same as proposal 2, except that all long-haul drivers would be required to use an electronic on-board recorder (EOBR). Option 5 is the same as proposal 4, except both long-haul and regional drivers must use an EOBR.

The FMCSA estimates that fatigue is directly or indirectly involved in 15 percent of all fatal and injury crashes involving a large truck, contributing to 755 fatalities and 19,705 injuries annually. We assume that options 1 and 2 would reduce these crashes by 5 percent annually, option 3 by 7.5 percent, option 4 by 20 percent for long-haul drivers and 5 percent for other drivers, and option 5 by 20 percent for long-haul and regional drivers and 5 percent for all other drivers. We did not include the benefit of a reduction in property damage only crashes.

All options would eliminate the record of duty status (RODS), reducing paperwork by between 32 and 37 million hours annually. The removal of this paperwork requirement accounts for between 70 and 50 percent of the overall benefit of these options.

Table ES-1 shows the costs, benefits, and crashes prevented for the 5 options. All dollar figures are for 10 years, at a 7 percent discount rate. Options 1 and 2 have the lowest benefits, with costs slightly higher than option 3, resulting in fairly high low benefits of over $1.7 billion. Option 3 has the lowest costs, at $2.6 billion, and net benefits of $2.4 billion. Options 4 and 5 have high costs and benefits, with net benefits of $2.3 and $3.4 billion, respectively.

Table ES-I
Costs and Benefits of Proposals

	Fatalities Avoided, Annual	Injuries Avoided, Annual	Discounted Benefits, Millions	Discounted costs, Millions	Discounted Net Benefits, Millions
Option 1	38	985	$4,418	$2,696	$1,721
Option 2	38	985	$4,418	$2,696	$1,721
Option 3	51	1,478	$5,059	$2,636	$2,423
Option 4	83	2,153	$5,364	$3,083	$2,281
Option 5	115	2,995	$6,803	$3,444	$3,359

Because the elimination of the RODS accounts for such a large percentage of total benefits, we also calculated the net costs and benefits independent of the paperwork benefits. Removing this benefit lessens the net benefits of all proposals, with all options except number 5 shifting from positive net benefits to negative, as demonstrated in Table ES-2

Table ES-2
Costs and Benefits Excluding Paperwork Benefits

	Discounted Benefits, Billions	Discounted costs, Millions	Net Benefits, Millions
Option 1	$1,283	$2,696	($1,413)
Option 2	$1,283	$2,696	($1,413)
Option 3	$1,925	$2,636	($711)
Option 4	$2,619	$3,083	($465)
Option 5	$3,597	$3,444	$153

Because paperwork constitutes such a large percent of the benefits, the options are not particularly sensitive to changes in the estimated value of key parameters. Sizeable changes in the assumed percent of crashes which are fatigue related, or in the percent of crashes that will be prevented, have only a minor impact on the results. Table ES-3 shows the impact of assuming that 7.5 percent of all crashes are fatigue-related, rather than the 15 percent used throughout this analysis. This change lowers the net benefits of all options, with option 4 suffering the largest decline.

Table ES-3
Impact of 7.5 Percent Baseline Fatigue Related Crash Rate

	Fatal Crash Reduction	Injury Crash Reduction	Safety Benefits, Mil	Net Benefits, Mil
Option 1	16	338	$642	$1,080
Option 2	16	338	$642	$1,080
Option 3	24	507	$962	$1,461
Option 4	35	738	$1,341	$1,003
Option 5	48	1,027	$1,829	$1,591

While there will be some administrative costs required to comply with these options, the FMCSA did not include these costs in this analysis. These costs are difficult to reliably predict, and are generally not significant. The FMCSA also did not estimate the number of property-damage-only crashes prevented by these proposals. Including these extra costs or benefits would not substantially alter the overall results. Additionally, property-damage-only crash information is not generally considered reliable.

The Agency's estimate of both the baseline percent of fatigue-related crashes and the percent reduction in these crashes caused by the options are on the low end of the likely range. The FMCSA chose these conservative values to avoid biasing the results towards a particular outcome. If significantly more than 15 percent of crashes are fatigue related, then the benefits of any option would be significantly higher.

Chapter 1
Background

Since 1938, the Federal government has regulated the number of hours that commercial motor vehicle (CMV) drivers can work and drive. While there have been many revisions over the last six decades, the essence of the regulations has changed very little. Many drivers and other industry observers believe the current hours of service (HOS) regulations are outdated, and do not adequately protect either the motoring public or CMV drivers. The Federal Motor Carrier Safety Administration (FMCSA) is therefore considering changes to the HOS regulations. Because the changes may have a significant economic and safety impact, the FMCSA has prepared this regulatory evaluation and regulatory flexibility analysis, in accordance with Executive Order 12866 and Department of Transportation (DOT) policy.

Chapter 1 of this report discusses the background to this proposal, including a brief description of the current regulations and some shortcomings with these regulations. Also included is a description of the options analyzed for this proposal. Chapter 2 provides baseline vehicle and driver information, with detailed estimates of driver operational characteristics. Chapter 3 presents the FMCSA's estimate of the number of fatigue related truck crashes, including a description of some relevant characteristics of these crashes. Chapter 4 details the benefits of the proposals, which consist of a reduction in fatigue related crashes and elimination of a significant paperwork burden. Chapter 5 analyzes the costs of the five options. Finally, chapter 6 compares the costs and benefits of the options, and presents some sensitivity analysis.

Background

Federal regulations divide drivers' time into four categories: on-duty driving, on-duty not driving, off-duty, and sleeper berth use. Driving time includes all time spent at the wheel of a CMV in operation. It includes much of the time the driver is waiting, while in control of the CMV, to be loaded and unloaded as well as time the vehicle is in motion. On-duty not driving time includes all time the driver is required to be ready to work but is not actually operating the controls of a motor vehicle. It includes, among other things, time inspecting the vehicle, time waiting for an assignment, time loading or unloading the truck, time repairing a truck, **and** any time the driver is engaged in an activity for which he will be compensated. Off-duty time includes time the driver is not on-duty. Sleeper berth time includes only resting and sleeping in the sleeper berth.

Current Federal HOS regulations limit driving and on-duty time, for any one period and cumulatively. After a minimum 8-hour off-duty period, drivers may not drive more than 10 hours, nor may they drive after having been on-duty (including both driving and non-driving time) more than 15 hours. After 10 hours of driving, or being on-duty for 15 hours, a driver may not drive again until he has a minimum of 8 hours off-duty. Drivers who work for companies which operate CMVs 7 days a week may not drive after having been be on duty more than 70 hours in the previous 8 days. If the company does not operate CMVs every day, the driver may not may not drive after having been on-duty more than 60 hours in the previous 7 days. Drivers may take an exception to the required 8 hours off-duty period by using a specification sleeper berth and splitting consecutive off-duty time into two periods.

Drivers are required to keep a record of their time in a record of duty status (RODS), commonly known as a logbook. The RODS must show the driver's status in 15 minute increments, as well as certain other information. Drivers must keep a current copy of their RODS in their possession while driving. Drivers who operate within a 100 air-mile radius of their normal work reporting location are not required to maintain a RODS, but their employers must maintain a time record.

Drivers in the States of Alaska and Hawaii, as well as drivers of oil field equipment, utility service vehicles, construction material and equipment vehicles, farmers, and ground water well drilling equipment, are granted various exemptions to some of the HOS and RODS provisions. The HOS regulations may be found at 49 CFR part 395, with relevant definitions in §395.2.

Much of the discussion in this evaluation uses the term fatigue. Fatigue has become a shorthand phrase denoting sleepiness, drowsiness, and low-alertness. However, the human-factors researcher Ivan Brown defines fatigue as the decreased capability of doing physical or mental work, or the subjective state in which one can no longer perform a task effectively. Fatigue can not be measured. What can and has been measured is how alert a person is, how they perform on tasks requiring sustained attention, hand-eye coordination, and responding to changes in the environment. Researchers have also measured changes in how the body functions, including brain wave patterns, and eyelid position, that relate to how alert or drowsy a person is. Because of its more common usage, this document generally uses the term fatigue.

There are two distinct but related safety issues concerning the existing HOS regulations. First, compliance with the regulations does not necessarily ensure that drivers are adequately rested and alert Drivers may comply fully with the regulations and still suffer from severe fatigue. Second, many drivers do not comply with these regulations. Numerous surveys and much anecdotal evidence indicate that many drivers violate the HOS regulations. These non-compliant drivers are especially susceptible to fatigue.

Moreover, a driver may be fully compliant with HOS regulations and not be sufficiently rested. Researchers understanding of sleep has improved dramatically since the original HOS rules were written. Researchers have examined the biology and physiology of sleep, the mechanics of circadian rhythms, differences between daytime and nighttime rest, and the effects of cumulative sleep deprivation, among other things. There is evidence that the existing HOS regulations do not comport well with this scientific understanding of the role and structure of sleep, and, when used to set minimum off-duty periods rather than maximum driving periods, might actually promote drivers' fatigue. According to an expert panel of sleep researchers and transportation safety experts convened by the

FHWA, "...the hours of service regulations are sorely inconsistent with the best available information today." (Expert Panel Report).

The FHWA convened an expert panel to review the current state of knowledge about sleep and fatigue, and to examine HOS options presented by the Agency. The expert panel included eight researchers expert in traffic safety, human factors, and sleep medicine. Panel members, who work in academia, government, safety organizations, and as private consultants, were provided summaries of over 80 (mostly peer reviewed) research reports compiled by the FHWA. The panel was asked to evaluate the current regulations and various proposals in light of the scientific understanding of sleep and alertness. This section describes some of the findings of the Expert Panel, particularly the discussion of the inadequacies of the present regulations. The complete Expert Panel Report may be found in the public docket.

One major concern of the panel was the absence of consideration of a 24 hour cycle in the HOS regulations. Human evolution responded to the natural light cycle, and human biology continues to exhibit strong cyclical effects. Human metabolism, and thus alertness, shows daily 24-hour patterns, including primary and secondary peaks and troughs. These peaks and troughs appear independent of the effects of light, indicating that they are deeply embedded in the human physiology. Since 1962, HOS regulations have had no 24 hour component. A driver could conceivably drive from midnight to 10 AM, rest from 10 AM to 6 PM, then resume driving until 4 AM the following day. This shortens the day by up to 6 hours, equivalent to an east-to-west transatlantic flight in terms of "jet lag".

Another concern of the Panel was the difference between daytime and nighttime driving. The Panel's report noted several problems associated with nighttime driving. First, as demonstrated by the Driver Fatigue and Alertness Study (Wylie et al), the strongest and most consistent factor influencing fatigue and alertness was time of day. Night driving was associated with a higher level of observed drowsiness, poorer lane-tracking, and degradation of mental performance. In addition, the Panel noted evidence suggesting that daytime sleep is not as restorative as nighttime sleep, with both fewer hours generally spent sleeping and a lower quality of sleep. Drivers generally agree that nighttime sleep is superior to daytime sleep (Abrams et al.). The result is that overall alertness and performance is lower in the nighttime than in the day, and crash risk is correspondingly higher. The Panel's report cites evidence suggesting that nighttime driving is associated with as much as a 4-fold or more increase in fatigue-related crashes. The existing regulations make no distinction between day and nighttime driving.

The Panel noted the importance of continuous time off-duty. They reported that sleep obtained in discontinuous segments is not as restorative as continuous sleep. The Expert Panel also cited studies which demonstrate that longer periods of off-duty time are associated with longer periods of sleep. The current regulations require that drivers have at least 8 continuous hours off-duty before returning to duty The Expert Panel criticized this requirement as inadequate, because it does not allow drivers time to travel to a resting place or to take care of personal needs, and because 8 hours off-duty time generally does not translate into 8 hours of sleep. Wylie showed that people who are off-duty for 8 hours generally only obtain about 5 hours of sleep (Wylie et al).

The Panel also asserted that there should be no differentiation between driving time and on-duty not-driving time. They cited several studies which show that performance of tasks declines with increased time on duty, regardless of how on-duty time is spent. The panel believes that all on-duty time should be treated the same, as the effect on driver safety is similar.

The Panel agreed that limits on cumulative on-duty time were required, because drivers might not get adequate rest, even if they have sufficient opportunity to rest on a daily basis. Like all workers, drivers have non-work responsibilities which may lessen the amount of time devoted to rest on a specific day, and it is often difficult to catch up on missing sleep. According to the panel, this can result in cumulative fatigue.

Related to a limit on cumulative on-duty time is the need for adequate recovery time. Because sleep loss is cumulative, it cannot be remedied by a single night's rest. The Driver Fatigue and Alertness study and other research demonstrated the prevalence of cumulative sleep deprivation in the motor carrier industry, with average sleep lengths of just under 4 to 5.5 hours. The Expert Panel also cited research which shows that nighttime sleep is more efficient than daytime sleep, with more time in bed spent sleeping. Therefore, the Panel recommended that any new regulations must allow for at least one off-duty period every seven days which encompasses two midnight to 6 AM periods.

The panel commented on the need for drivers to have advance knowledge of their work schedule, and on the specific issues related to sleeper berth use and split shift driving. As noted above, the Expert Panel report is available for review in the public docket.

While drivers who abide by the HOS rules may be fatigued, the situation of drivers who are not in compliance is undeniably worse. Whatever the limitations of, for example, 5 to 6 hours of interrupted sleep, it is clearly more restorative than no sleep. Unfortunately, many drivers violate the HOS regulations. The Insurance Institute for Highway Safety (IIHS) interviewed over 1,200 drivers at truck stops, truck inspections stations, and agricultural inspection stations in the early 1990s. Based on the drivers' responses, the authors classified 73% of the drivers as hours-of-service violators (Braver et al.). A 1995 survey of over the road drivers in New York State found that over one-third reported driving more than 60 hours in a typical week, and a similar proportion reported working 70 hours in a typical week. More than 40 percent of respondents reported always/often/sometimes driving more than ten consecutive hours without 8 hours off-duty (McCartt et al.). A more recent survey performed by the University of Michigan's Trucking Industry Program (UMTIP) corroborated this high violation rate. UMTIP surveyed over 800 mostly over-the-road drivers at a number of truck stops in the midwest in 1997. Only 16% of drivers surveyed reported that log books were generally accurate, and 56% stated that they had worked more hours than recorded in their RODS in the last 30 days. The average driver worked over 64.3 hours in the previous 7 days. Twenty five percent of drivers reported working at least 75 hours in the last 7 days, and 10% of drivers reported working more than 90 hours. The UMTIP survey is described at greater length in Chapter 2.

Thus, drivers who comply with the HOS regulations may still not be adequately rested, and the significant percentage who do not comply are assuredly not rested.

Other organizations have also indicated their concern over driver fatigue, and their concomitant belief that the present hours of service regulations do not adequately ensure that drivers are rested. Driver fatigue was voted the number one safety concern of the 1995 Truck and Bus Safety Summit, a meeting of over 200 drivers, motor carrier representatives, government officials, and safety advocates. The National Transportation Safety Board has asked the FHWA to investigate and promulgate new regulations to combat driver fatigue, and Congress has mandated that the FHWA issue a rule “dealing with a variety of fatigue-related issues” in the ICC Termination Act of 1995.

Proposals

Improved understanding of the mechanics of fatigue from sleep research, intense interest expressed by Congress and others, and the perceived widespread violation of the existing hours-of-service regulations prompted the FMCSA to consider changing them. As was noted above, the underlying goal of the current regulations is to prevent drivers from driving more than a certain number of hours per day and week. The lodestar of the proposals under consideration is to assure that drivers have an opportunity to obtain sufficient rest. The options are described below.

Option 1 12/12

Under this proposal, all drivers must have a minimum of 12 consecutive hours off-duty in every 24 hour period, and may work for the other 12 hours. Rest and meal breaks within the 12 hour work period would not count as off-duty time. Drivers must also have at least 58 hours of consecutive off-duty time every week, including a minimum of two midnight to 6 AM periods. This would allow for more than 2 full days off to obtain quality, uninterrupted, restorative sleep.

Motor carriers would be encouraged to start drivers work days approximately the same time each day, with some leeway. Motor carriers would be encouraged to limit drivers backwards rotating their shifts to no more than 1 hour a day, with no limits on forward shifting. A driver who works from 6 AM to 3 PM Monday, and then takes the required 12 hours off, should not begin work again until 5 AM Tuesday, even though he accumulates 12 consecutive hours off-duty by 3 AM. In this case, the driver would be encouraged to take 14 consecutive hours off-duty, since the recommendation on backward shifting schedules would prevent him from starting before 5 AM.

Although backward rotation is disruptive of drivers circadian rhythm, as noted previously, the FMCSA does not currently propose to ban the practice. The Agency does not believe the scientific community has reached a consensus on the magnitude of the harm to drivers from a backwards rotating schedule. While credible research agrees on the undesirability of this practice, it is not clear how large a role backwards rotating schedules, in isolation, play in fatigue-related crashes.

The FMCSA considered mandating the regularity practices outlined above, but the costs were found to be unexpectedly high. Given the high costs and the uncertainty over the importance of irregularity, the FMCSA refrained from requiring regularity. Nonetheless, the Agency does encourage drivers and motor carriers to ensure that driving begins at approximately the same time each day.

All the options change the definition of on-duty and off-duty time to be consistent with Department of Labor (DOL) regulations governing the minimum wage, since most employed drivers are subject to the minimum wage provisions of the Fair Labor Standards Act (FLSA). By adopting the DOL's definitions, the FMCSA will be able to rely largely on DOL-required paperwork to enforce the HOS regulations.

Because the FMCSA proposes to rely primarily on DOL-required paperwork, drivers would no longer have to prepare an RODS. Instead, on-duty and off-duty time would be monitored by a DOL-required time card or sheet, which includes the time a driver checks into and out of work. Time cards would be kept at the drivers normal work reporting station, and most drivers would not have to carry their time card while driving. Because of their extended absence from their normal work reporting stations, long haul and regional drivers would be required to have a current time card, with annotations of the locations where they change their duty status, on their vehicles while driving.

Option 2

For most drivers, option 2 is the same as option 1. The majority of drivers must have 12 consecutive hours off-duty However, this option provides alternatives for two groups of drivers: (1) long haul and regional drivers, and (2) split shift drivers and work truck and bus drivers

Long-haul and regional drivers must have a minimum of 12 hours off-duty, 10 of which must be consecutive. These drivers would be allowed to drive for up to 12 hours. Two of the off-duty hours could be either contiguous with the 10 consecutive off-duty hours, or taken during the 12 hours of driving.

Long-haul and regional drivers would also have a choice in calculating weekly driving time. They could follow the procedure outlined in Option 1, whereby they would need 58 consecutive off-duty hours, including 2 consecutive midnight to 6 AM periods, at the end of the work week. Alternately, they could use a two week schedule. Under the two week schedule, drivers would have one short and one long "weekend". For the short weekend, drivers would need 32 hours of consecutive off-duty time, including 2 consecutive midnight to 6 AM periods. After the short weekend, the driver could drive up to an additional 48 hours over the next 4 days, but then would require 82 consecutive hours off-duty, including 2 consecutive midnight to 6 AM periods, before returning to work.

Work truck and bus drivers are those who spend less than one third of their on-duty time driving a truck or bus. This category excludes drivers for for-hire motor carriers of passengers. These drivers may only drive 5 hours per day, with a weekly maximum of 30 hours. They must have at least 9 consecutive off-duty hours per day, and 2 additional off-duty hours which may be either contiguous with the 9 hour off-duty period, or taken during the driver's work period. Work truck and bus drivers may work up to 13 hours a day, and they are not allowed to drive 15 hours after beginning work. Work truck and bus drivers must also have a minimum of two midnight to 6 AM off-duty periods per week.

Option 3 - Option 2 with exemptions and nighttime differential

This is the same as option 2, except all drivers would be limited to a maximum of 18 hours of driving per week between the hours of midnight and 6 AM. The purpose of this option is to limit the number of hours driving in the middle of the night, because of abundant evidence which indicates that this is the most fatiguing period for drivers.

Option 4 - Long-Haul Drivers must use an EOBR

This is the same as option 2, except long-haul drivers must use an electronic on-board recorder (EOBR). The EOBR will allow companies and enforcement officers to more accurately monitor drivers compliance with the hours-of-service regulations.

Long haul carriers which employ fewer than 20 drivers must use an EOBR within 4 years of promulgation of a final rule. Carriers with 21 to 49 drivers would have 3 years to comply, and those with more 50 drivers would need an EOBR within 2 years.

Local and work truck drivers will be allowed to use the DOL time card. Because of their extended absence from their reporting location, regional drivers will be required to continue to use the existing RODS. Likewise, long haul carriers must continue to use the RODS until they begin using an EOBR

Option 5 - Long-Haul and Regional Drivers must Use an EOBR

This is the same as option 2, except both long-haul and regional drivers must use an EOBR. These carriers must continue to use the RODS until they begin using an EOBR.

Options

As mentioned above, the linchpin of all these options is to allow drivers adequate consecutive off-duty time to obtain sufficient rest. Science indicates that there is no precise length of time all drivers can operate safely. That point varies with the amount and quality of sleep a driver has obtained. Drivers who have had only three hours of sleep in the last 24 hours, for example, are far less likely to drive safely, for as many hours, as their counterparts who have slept 10 of the previous 24 hours. So rather than focus on a maximum driving limit, the FMCSA proposes to establish minimum opportunity-to-rest times.

As a result of this proposed focus, some drivers may be able to drive more hours in a work-rest cycle than are currently permitted. For example, while drivers are currently limited to 10 hours of driving before taking an 8-hour break, under these proposals some drivers could drive as many as 12 hours before stopping. There are several reasons the Agency believe that this would not increase driver fatigue.

First, although drivers are currently limited to 10 hours of driving, they may drive during, or after, their 12th hour on-duty Individuals who begin their work shift with non-driving on-duty tasks, which include such strenuous activities as loading or unloading trailers, may end up driving into the 15th hour on-duty The expert panel noted that there should be no distinction between driving and other non-driving on-duty tasks, arguing that "cumulative hours on duty increases fatigue." Research suggests that crash risk increases with on-duty time, rather than time on a specific task.

Second, a driver may drive as many as 16 hours in a 24 hour period under the current regulations. As noted previously, a driver may drive 10 hours, take 8 hours off duty, and then continue driving for another 10 hours. This equals 16 out of 24 hours, and 20 out of 28. By contrast, the proposed options would limit drivers to 12 out of 24 hours (or fewer, for many drivers).

Third, the options would require that drivers obtained between 9 and 12 consecutive hours off-duty, depending on the driver type and option. Currently, drivers are only required to have 8 consecutive hours off-duty, which often does not leave sufficient time for rest (Wylie et al).

Fourth, the weekly limitations proposed guarantee that drivers obtain sufficient cumulative rest, and that some of that rest takes place in the midnight to 6 AM period, when sleep is most restorative. The existing HOS regulations make no distinction between daytime and nighttime driving.

Finally, as noted above, these proposals also encourage drivers to begin work at approximately the same time each day, and to obtain sufficient cumulative rest at the end of each work week. Research indicates this combination will enhance driver's overall levels of rest and attentiveness.
Thus, while the Agency understands that these proposals may result in some drivers driving for longer periods than are now allowed, we believe the cumulative effect of these changes will be increased driver alertness and safety.

While drivers who comply with the regulations should be more rested, potential violations must also be addressed. We believe that this proposal will result in fewer violators, and those who continue to exceed the maximum allowable hours will still be subject to FMCSA fines and other penalties. A frequent comment made at the thirteen nationwide outreach sessions held in support of the zero-base review of the FMCSRs was the need to make the regulations more understandable. These proposals are simpler and more comprehensible than the existing standards The Agency is proposing to simplify the regulations by eliminating the on-duty not driving category, making many drivers subject to a simple 12/12 schedule, and removing the log book requirement. We believe that people are more likely to comply with rules which are easier to understand and that fit their physiological needs.

In addition, Options 4 and 5, which require that certain drivers use EOBRs, will make it more difficult for drivers to violate the HOS regulations. EOBRs must produce a paper printout or other format which can be read at the roadside. This output will allow enforcement officers to determine the number of hours the vehicle has been in operation, and when the operation began Enforcement officers will have a minimum of two accurate data points, which will make it easy to determine how long a driver has been on-duty. It may still be possible for drivers to conceal the number of their driving hours, but the use of an EOBR will make it significantly more difficult to do so. EOBRs will also allow motor carriers to better monitor driver's driving time. Accordingly, the FMCSA assumes that options 4 and 5 will lead to a greater reduction in fatigue-related crashes than the other three options.

Many drivers have argued that the current regulations do not comport with their schedules, forcing them to violate the hours-of-service regulations. Specifically, the fact that drivers are often not on a 24-hour cycle skews their natural sleep/wake patterns, which may not be aligned with their driving hours. Drivers may be required to go off-duty when they are not tired, or they may have to continue driving during a circadian trough. Some drivers choose not to go off duty and violate the HOS regulations rather than discontinue driving if they do not feel tired. By encouraging drivers to operate on a 24-hour schedule, drivers' driving schedules and circadian rhythms should be more nearly congruent, lessening the tendency for drivers to drive over hours and while fatigued.

While work truck and bus drivers are allowed the least driving time, they may have the greatest amount of time on-duty. A work truck driver could be on duty for 65 hours in a week, and may operate a CMV up to 15th hours after commencing work. The FMCSA is proposing these more lenient provisions because of these drivers' reduced risk of fatigue-related accidents. Research indicates that these drivers are an order of magnitude less likely to be involved in a fatigue-related crash than are other drivers. Chapter 3 describes the research in more detail.

Chapter 2
Baseline Vehicle and Driver Data

The regulatory options under consideration distinguish between drivers based on the characteristics of their operations. Therefore, the FMCSA generated estimates of the number of vehicles and drivers in the relevant categories. This chapter presents these estimates, as well as information on driver characteristics.

While the Agency is reasonably confident in the estimate of the total number of drivers, there is more uncertainty about the distribution of drivers by operational type. The options envision 5 classes of drivers: long haul drivers, regional drivers, split-shift drivers, work-truck drivers, and local non-work drivers There is no publicly available data which classifies drivers into these categories, so the FMCSA developed them from data collected for other purposes.

The FMCSA relied largely on data from the Truck Inventory and Use Survey (TIUS), a survey conducted every five years by the Bureau of the Census of the U.S. Department of Commerce. TIUS is described in detail in Appendix A. The 5 **driver** categories were culled down to 4, because no data is available on split-shift drivers. We assumed that vehicles with an average trip distance of more than 500 miles are long haul, those with average trip distances of between 200 and 500 miles are regional, and those less than 200 miles are either local or work trucks, depending on their primary use and vehicle body type. These simplifying assumptions are reasonable but not unassailable. Therefore, results pertaining to costs and benefits by type of operation are considered less reliable than overall results.

1) Number of Drivers and Vehicles

The number of drivers was based on data from the FHWA's 1996 Controlled Substances and Alcohol Testing Survey, supplemented by information from the Motor Carrier Management Information System (MCMIS) census file. The survey is a statistical sample of several thousand motor carriers selected from the MCMIS file, and it included a question about the number of CDL-drivers employed. These data and sampling weights from the survey were used to generate an estimate of CDL drivers. This number was multiplied by the ratio of non-CDL to CDL drivers from MCMIS to estimate non-CDL drivers, and the numbers were summed to generate a total. The FMCSA estimates that there are 6.4 million interstate and intrastate CMV drivers subject to the current hours of service regulations.

This regulatory analysis includes both interstate and intrastate drivers. While the current HOS regulations only apply to interstate drivers, all States have adopted compatible regulations governing intrastate drivers. 48 States and the District of Columbia receive grant money through the FMCSA's Motor Carrier Safety Assistance Program (MCSAP). One requirement of participation in MCSAP is that the State adopt MCSAP compatible regulations. Accordingly, the FMCSA believes that most States will adopt regulations substantially similar to what the Agency chooses. Therefore, the options under consideration will effectively regulate both interstate and intrastate drivers, and both have been included in this analysis.

The FMCSA categorized the 6.4 million drivers by operational type, compatible with the definitions in the HOS options. Vehicle data from the TIUS was used. The 1992 TIUS, the most recent survey completed, obtained detailed physical and operational data on more than one hundred and twenty five thousand trucks. After eliminating trucks under 10,000 pound gross vehicle weight rating (GVWR) from the sample, vehicles were stratified based on the percent of miles accounted for by various trip lengths. Missing data were distributed based on the distribution for similar non-missing vehicles. Single-unit trucks with predominately short trips were stratified as work trucks or non-work trucks, based on the trucks' repotted major use. The FMCSA assumed that drivers were distributed proportionately to trucks, which resulted in the following driver counts.

Table 1
Number of Drivers by Operation Type

Operation Type	Number
Work Truck	1,190,740
Non-work Local	3,997,023
Regional	823,863
Long Haul	424,804
Total	6,436,430

Appendix A explains in detail the process used to generate the number and distribution of drivers.

We also used TIUS to develop estimates of the vehicle miles traveled (VMT) by trip distance and vehicle type. Because the Trucks Involved in Fatal Accidents (TIFA) file uses the same trip distance definitions as TIUS, these estimates allow us to analyze differences in risk for fatal crashes, including both fatigue- and non-fatigue-related crashes. TIUS respondents report the percent of miles in each trip category, as well as the total number of miles driven. These figures were multiplied for each vehicle, then summed to yield a total. A given vehicle could have some miles in each of the trip distances listed below (although this was not often the case). Estimates are presented in Table 2.

Table 2
100 Million Vehicle Miles Traveled
by Power Unit Type and Trip Distance

	< 50	50-100	100-200	200-500	> 500	Total
Straight, miles	202	83	31	17	7	340
Straight, percent	59.41%	24.41%	9.12%	5.00%	2.06%	100.00%
Tractor, miles	82	103	107	162	236	690
Tractor, percent	11.88%	14.93%	15.51%	23.48%	34.20%	100.00%
Total Miles	284	186	138	179	243	1,030
Percent	27.6%	18.1%	13.4%	17.4%	23.6%	100.0%

Straight trucks and tractors are used differently. Almost 60 percent of straight trucks have a most frequent trip distance of less than 50 miles, compared to just 12 percent of tractors. At the other extreme, tractors accumulate over one third of their miles in trips of greater than 500 miles, compared to one in 50 miles for straight trucks.

Partly because of the difference of travel between straight trucks and tractors, the distribution of trucks differs considerably from the distribution of travel. Regional and long haul trucks (those with a most frequent trip distance of more than 200 miles) account for over 40% of miles but just 13% of vehicles. The breakdown of trucks by most frequent trip distance is presented in the following table.

Table 3
Truck Registrations
by Power Unit Type and Trip Distance

	< 50	50-100	100-200	200-500	> 500	Total
Straight	2,215,105	356,653	98,398	40,772	22,768	2,733,696
Tractor	341,666	206,752	148,517	201,297	243,334	1,141,566
Total	2,556,771	563,405	246,915	242,069	266,102	3,875,262
Percent	66.0%	14.5%	6.4%	6.2%	6.9%	100.0%

Additional information on the development of these numbers can be found in the UMTRI report in the public docket.

2) Baseline Driver Survey Information

The FMCSA relied extensively on a driver survey conducted by the University of Michigan Trucking Industry Program (UMTIP) to analyze the costs of the proposed options. The DOT did not sponsor this survey, and therefore some of the definitions do not precisely match those in the NPRM. This section describes the survey and presents summary information on the results. While most of the text is based on the following tables, some of this discussion relies on information not included in this evaluation. The UMTIP survey analysis has been placed in the docket.

The driver survey used a two-stage randomized design in five Midwestern states. UMTIP selected truck stops at random from the population of buck stops in these states, stratified based on the number of parking spaces for trucks as a proxy for truck traffic. Subjects were chosen at random (every n^{th} individual who walked through the door). The survey took approximately 45 minutes and drivers were paid $20 to participate. The response rate was 60% (including conversions for those who had insufficient time at the truck stop but were interviewed at home). An additional 6% response was achieved using a five minute questionnaire. UMTIP also surveyed drivers who were refueling to confirm sample validity, and achieved an 96% response rate.

Drivers were asked if they were local or long haul. Drivers who called themselves local were classified accordingly. Drivers who called themselves long haul drivers were so classified if their average trip length was greater than 500 miles; otherwise they were categorized as regional. These definitions are used throughout this section. However, the reported traveled distances may be high, especially for local drivers. It is extremely unlikely that local drivers actually drive more than 80,000 miles per year, as reported in the survey. The survey most likely undersamples local drivers, as they are unlikely to stop at truck stops. Those who do, regardless of how they categorize themselves, are not likely to be representative of most local drivers. Therefore, we did not use these definitions in the analysis in Chapter 5. We believe that both long haul and regional drivers in the survey are likely to fit the NPRM's definition of long haul drivers. In this evaluation, long haul driver characteristics (such as wages and hours worked) are assumed to equal an average of those reported for long haul and regional drivers in the survey. Likewise, we assumed that local drivers in the survey are most likely to match the NPRM's definition of other (non-long haul, non-work truck) drivers.

Table 4 shows the trends for mileage driven by individual drivers. The average driver covers 112,765 miles annually, and long-haul drivers drive 124,475 miles. Means exceed medians, demonstrating the extent to which high mileage figures dominate. Indeed, the top 25 percent of all long haul drivers reported exceeding 150,000 miles and ten percent exceeded 170,000 miles.

Table 4
Annual Miles

	Full Survey	Full Survey, Local Drivers	Full Survey, Regional Drivers	Full Survey, Long Haul Drivers
mean	112,765	82,065	103,617	124,475
10th pct	60,000	25,000	50,000	78,000
25th pct	90,352	50,000	80,000	100,000
median	110,000	80,000	100,000	120,000
75th pct	130,000	125,000	125,000	150,000
90th pct	160,000	130,000	145,600	170,000
Obs	451	49	113	281

The report also shows that employee drivers drive 5.8 percent more miles than do owner-operators, and that union drivers run nearly 7 percent fewer miles.

The driver survey shows that, on average, drivers worked 64.3 hours in the past seven days, including driving and on-duty-not-driving. The survey also shows, somewhat surprisingly, that local drivers work as many hours as do long-haul drivers. We suspect this is probably because of the lack of representativeness of local drivers in the survey discussed above. In any case, the data presented in Table 5 suggest a broad pattern of violation, with the top 10 percent of all drivers averaging 94 hours, including a 97 hour average for local drivers. At the median, only the local drivers stay below the 60 hour limit and regional drivers hit that limit exactly.

Table 5
Hours Worked in Last 7 Days

	Full Survey	Full Survey, Local	Full Survey, Regional	Full Survey, Long Haul
mean	64.3	65.0	62.6	65.0
10th pct	36.0	44.0	38.0	33.0
25th pct	50.0	45.0	50.0	50.0
median	62.0	58.0	60.0	65.0
75th pct	75.0	72.0	70.0	80.0
90th pct	94.0	97.0	80.0	96.0
Obs	451	49	113	281

Again, non-union and employee drivers work longer hours than either union members or owner operators.

The following two tables report hours working and driving in the last 24 hours. They reveal a direct, if modest, relationship between the number of hours worked per day and the length of trip taken by the driver. Long-haul drivers work the greatest number of hours; at the mean, long haul drivers work 12 percent more hours during any single day than do regional drivers, and 15 percent more hours on any single day than do local drivers. Not surprisingly, they also drive more of those hours and spend less of their time in any given day performing non-driving labor. At the mean, long-haul drivers perform non-driving work 23 percent of their time, while comparable figures for regional and local drivers are 25 percent and 37 percent.

Table 6 suggests that many drivers may routinely exceed the daily hours-of-service rules. At the 75th percentile, long-haul drivers are working 15.5 hours. At the 90th percentile long haul drivers work I9 hours, leaving only 5 in the last 24 for non-work activity. This suggests that a significant percentage of all long-haul drivers may be in daily violation of the HOS limits. As noted above, other studies have also found high violation levels.

Table 6
Hours Worked in the Last 24

	All	Local '	Regional	Long Haul	Reg+ LH
obs	436	45	107	278	385
mean	11.35	10.38	10.63	11.93	11.28
10th pct	5.5	7	6	5	5.5
25th pct	8	8.25	8	8	8
median	11	10.25	10.5	11.5	11
60th pct			11.5	12.5	12
70th pct			12.5	14.35	13.4
80th pct			13.5	15.5	14.5
90th pct	18	16	16	18.5	17.5

Table 7
Hours Driven and Worked in the Last 24

	All	Local	Regional	Long Haul	Reg + LH
Obs	436	45	107	278	385
Mean Driving Hrs	8.33	6.6	7.87	8.95	8.41
Median Driving Hrs	8	7	8	9	8.5
Mean Non-Drive Work	3.02	3.78	2.76	2.98	2.87
Median Non-Drive Work	2	3	2.25	2	2.1
Ratio Mean Non-Drive / Mean Drive Time	26%	37%	25%	23%	24%
Ratio Median Non-Drive / Median Drive Time	21%	33%	23%	17%	20%

Table 8 shows that long-haul drivers put in the most work time per trip, and their trips are considerably longer than those of their local or regional counterparts. However, long-haul drivers spend a disproportionately large percentage of their time waiting during trips. The average driver waits more than twice as many hours as he performs non-driving work, but the distribution is skewed. Local drivers wait somewhat less than they work (possibly because they are usually paid by the hour) but long haul drivers wait almost three times as long as they perform non-driving work.

A great deal of efficiency is lost when drivers spend their on-duty time waiting. While drivers are arguably creating value when they are working loading or unloading a truck, they are not creating any value when they are waiting for a dispatch or delivery This inefficient use of their time is the source of a great deal of slack in the system. Many drivers are not paid directly for this time, or earn a very small piece-work rate for activities. The Fair Labor Standards Act requires that employees be paid for all time they work or are “engaged to wait”, which includes time driver’s spend waiting for a dispatch or for a vehicle to be unloaded. Drivers’ weekly wages must be high enough that they receive the minimum wage for all hours worked, including both driving and waiting time. Therefore, employee drivers may be legally paid for waiting time, but their marginal pay is generally close to zero. Piece work drivers (those paid by the mile or the load) would generally receive the same pay whether they waited 10 hours for a dispatch or 1 hour. As long as the drivers cumulative pay results in an average hourly rate equal to, or greater than, the minimum wage, the driver’s employer is in compliance with the relevant provisions of the FLSA. However, because marginal hourly pay equals zero, drivers perceive this time as unpaid, a perception that most economists would support. Accordingly, this discussion refers to this time as unpaid, while making no judgement about compliance with the FLSA.

This unproductive time is relatively costless to the shipper, consignee, and the trucking company, but represents a significant opportunity cost to the driver. The economic cost is reflected in high turnover and low human capital investment, as well as a tendency for drivers to pack in working (mainly driving) hours in addition to unpaid waiting time to make up for their lost earnings.

Table 8
Time Working and Waiting in the Last Trip

	All	Local	Regional	Long Haul
mean hrs worked	22.5	8.3	13.8	29.6
median hrs worked	14.5	7.7	10.3	20.5
mean minutes wait	282.9	73.7	196.7	372
median minutes wait	90	30	60	120
mean minutes non-drive work	117.8	94.6	109.3	126.6
median minutes non-drive work	60	60	45	60
mean wait as % non-drive work	71%	44%	64%	75%
median wait as % non-drive work	60%	33%	57%	67%

Drivers clearly spend a significant proportion of their on-duty time on non-driving tasks. When this time is unpaid, it may contribute to excessive hours, as drivers may illegally log unpaid time as off duty. Table 9 shows paid time as a percent of all non-driving time, and indicates that much non-driving work time is unpaid. At the mean, 29 percent of ail non-driving time is paid, but at the median the percentage of paid time is zero. This means that more than half of all drivers earn nothing for this labor. Most union drivers are paid for their time, as 72.7 percent of the union driver's time is paid at the median, while for non-union drivers, at the median their ratio of paid time to total non-driving time is zero percent. At the 75th percentile 70.6 percent of the non-union driver's total non-driving time is paid, while the corresponding figure for union drivers is 100 percent. Owner-operators have an even worse problem than do ordinary non-union drivers, as at the 90th percentile only 66.7 percent of their total non-driving time is paid. (These data are not included in this table, but can be found in the complete report in the docket).

Table 9
Paid Time as a Percent of Total Non-Driving Time

	Mean	Median	Number
All	29.0%	0%	312
Local	50.4%	40.0%	29
Regional	35.0%	0.0%	78
Long Haul	22.1%	0.0%	201
OTR Employees	31.6%	0.0%	199
OTR Owner-Operators	12.6%	0.0%	82
Union Employees	57.4%	72.7%	31
Non-Union Employees	31.2%	0.0%	201
Paid Time as % of Non-Drive Time, All Drivers	29.0%	0.0%	312
Paid time as % of Non-Driv ime, Paid by Mile	36.2%	0.0%	148

Earnings

The costs associated with the alternate proposals will largely be reflected in changes in drivers pay. Accordingly, a brief discussion of the level and method of drivers pay is warranted. The UMTIP report in the docket contains a more comprehensive discussion of driver pay.

While mean driver earnings are relatively high for somewhat skilled but generally not highly educated workers, drivers work an excessive number of hours to achieve their earnings levels. While the average driver earns more than $36,500 annually, he also works an average of about 3,300 hours per year to do it. This is more than half again as many hours as the full time standard year in the United States, and considerably greater than 50 percent more hours than the average employee actually works.

Table 10 shows that long haul drivers make less than regional drivers. This is consistent with previous research that showed that the lowest paid drivers worked for long-haul TL carriers. That research showed that rates for drivers working for regional carriers averaged 31.0¢ per mile while those working for national carriers averaged 25.1¢ per mile. The highest pay rate went to national LTL carriers at 40.1¢ per mile, while the mileage rate for national TL drivers was 22.7¢, 43% less than national LTL carriers (and they are generally not paid for their non-driving labor). (Belzer).

Table 10
Annual Wage

	Full Survey	Full Survey, Local	Full Survey, Regional	Full Survey, Long Haul
mean	$ 36,572	$ 37,237	$ 37,907	$ 35,945
10th pct	$ 19,000	$ 20,000	$ 22,000	$ 18,000
25th pct	$ 27,000	$ 26,000	$ 30,000	$ 25,235
median	$ 36,000	$ 40,000	$ 36,000	$ 35,000
75th pct	$ 46,000	$ 46,000	$ 48,000	$ 45,000
90th pct	$ 53,000	$ 53,000	$ 53,000	$ 53,000
Observations	451	49	113	281

Owner-operators earn somewhat less than do company drivers, suggesting profits may be quite low (owner-operators often commingle these concepts). While median earnings are the same, mean earnings of owner-operators are about 5 percent lower than those of company drivers. Owner operators drive fewer miles and work fewer hours, as was noted above, but their returns on capital investment appear relatively low.

As previous research has shown, the most stiking difference in driver wages comes from the influence of unions. Collective bargaining clearly provides union drivers with great advantages in comparison with their non-union counterparts. Collective bargaining appears to provide a nearly 26 percent earnings advantage over the non-union employees. Since non-union employees also work 8.3 percent more hours, the real advantage may be closer to 34.3 percent, not including the value of benefits (which also is considerably higher for unionized employees). Data on owner-operators and union employees may be found in the UMTRI report in the public docket.

Most over-the-road drivers are paid on a contingent basis, that is, by the mile or by a percentage of the load revenue. The latter method is most common among owner-operators, who usually act as subcontractors for motor carriers. It also is common among non-union drivers, but is relatively uncommon for union drivers.

Night Driving

The UMTIP survey asks drivers how many hours they worked between the hours of 11 PM and 7 AM, commonly known as the “graveyard shift.” Drivers reported a relatively small amount of night driving, 29.0 percent at the mean. Local and long haul drivers put in a somewhat smaller proportion of their time in night driving, and regional drivers a higher proportion.

Option 3 proposes limiting night driving (defined as between 12:00 AM and 6:00 AM) to 18 hours per driver per week. The average driver works 64.3 hours a week (Table 5), of which 26 percent (Table

7) is non-driving. Multiplying 64.3 by .74 suggests that the average driver drives 47.6 hours per week. Based on the "last full trip" information, the average driver in the sample spends 29 percent of his or her driving time between the hours of 11:00 p.m. and 7:00 a.m. (the hours asked about in the survey). If we assume a uniform distribution of reported night driving over this period, then we can estimate that the average driver would have 75 percent of his overall night driving hours in the policy-relevant six hours (between midnight and 6 AM). We calculate that the average driver would be driving 21.75 percent of his time during the proscribed hours 0.75 x 0.29). Using the sample mean driving total of 47.6 hours, this suggests the average driver currently drives 10.4 hours during the midnight to 6:00 AM period each week, well within the prospective limits. UMTIP believes this figure is conservative, since they ended up adjusting their interview schedule because fewer drivers were available to interview in the early morning.

These calculations are based on the mean; depending on the characteristics of those drivers exceeding the mean either in hours worked or percent of night driving, these characteristics might be different at the extremes. For example, in the LTL sector most of the regional carriers' drivers operate through the night, five days a week, but do so within the 60 hour weekly limit. In the national LTL and in the package delivery sector, tractor trailer combinations run throughout the night as well as during the day.

The following tables show the percent of hours driven between midnight and 6 AM for different operational types.

Table 11
Estimated Night Percent

	Local	egional	ong Haul	All
mean	20%	23%	21%	21%
median	13%	20%	19%	19%

Table 12
Estimated Night Percent

	TR Emp	TR OOs	Emp Drive, Union	Emp Drive, Non-Union	Mileage Paid
mean	21%	23%	24%	21%	21%
edian	19%	19%	23%	17%	18%

Chapter 3

Baseline Safety Analysis

The objective of this proposal is to reduce the number of fatigue-related truck and motorcoach crashes. The overall benefit will therefore depend on the current number of these crashes. This section discusses the number of fatigue-related truck accidents, in three parts. First, we discuss existing estimates of the number of fatigue-related truck crashes, and attempt to explain why these estimates differ. Second, we use the Trucks Involved in Fatal Accidents database to generate estimates of fatigue-related truck crashes by operation type, hours driving, and time of day. Finally, we present adjusted estimate of the number of fatigue-related truck crashes by operation type.

1) Existing Crash Estimates

There are significant differences in published estimates of the number and proportion of fatigue-related truck crashes. Much of the difference results from the differing analytical approaches used, particularly differences in the set of crashes analyzed. Generally speaking, these studies can be divided into two classes: those relying on large scale accident data tiles, and those based on more intensive analysis of a smaller number of crashes.

The FHWA and the National Highway Traffic Safety Administration (NHTSA) have conducted several fatigue studies using large scale data bases, primarily the Fatality Analysis Reporting System (FARS) and the General Estimates System (GES). These databases, which are managed by NHTSA, are based largely (but not exclusively) on police accident reports (PARS). Most police accident forms contain a field for driver contributing factor, and among the choices are driver fatigue, drowsiness, or asleep at the wheel. In most analyses, crashes in which one of these fields is checked are classified as fatigue-related.

Crash analysts frequently criticize use of PARS for fatigue analysis, as they assert that PARs understate the true extent of fatigue. There are a number of difficulties police face in determining whether fatigue contributed to an accident. First, the responding officer's primary concern is assisting accident victims and restoring the flow of traffic. Investigating the causes of the accident is often a second (or lower) level concern. Second, few police officers are trained in accident reconstruction, and they therefore do not have the training to conduct a detailed investigation of the physical and mechanical evidence. Therefore, many police officers must rely on eyewitness and other oral evidence.

This results in an additional problem. By the time an officer interviews surviving crash-involved drivers, any signs of fatigue are likely to have worn off. The stress of the crash produces an adrenaline surge, eliminating any traces of fatigue and in fact enhancing the drivers sense of alertness and awareness and acuity, at least for the short term

Some analysts have argued that in two-vehicle truck-involved fatal crashes, the investigating officer may have to rely inordinately on the testimony of the truck driver, since the truck driver is five times more likely to survive a fatal crash than the driver of the other vehicle. The truck driver has an obvious incentive to minimize the role of fatigue in his actions, which could result in underreporting of fatigue involvement. However, a report on two-vehicle truck-involved crashes does not find significant evidence of a "survivors bias". Dan Blower of the University of Michigan Transportation Research Institute (UMTRI) examined almost 5,500 two-vehicle truck and passenger vehicle fatal crashes in 1994 and 1995. In 4,55 1 of these crashes, the passenger vehicle driver died while the truck driver survived. In these case, 82% of passenger vehicle drivers were coded for contributing to the crash, as opposed to only 24% of truck drivers. Truck drivers were the only fatality in 90 cases, and truck drivers were coded in 58% of these cases, while passenger vehicle drivers were only cited in 47% of these crashes. This suggests some sort of "survivors bias". However, Blower notes that this explanation is too simple, and he examined the larger number of fatal crashes where both drivers survive. The car driver is assigned a factor in 74% of these cases, and the truck driver in 34.5%. The author notes that "If driver survival explained the overall preponderance of driver factors for passenger vehicle drivers, one would expect factors to be about equal where both survived", which is not the case (Blower).

Smaller scale studies have a different set of problems, the most significant of which is generalizability. While limiting the number of accidents studied can allow for more in-depth analysis of each specific event, the results of these studies can not automatically be applied to all crashes. Thus, the results of the National Transportation Safety Board's (NTSB) 1995 study of single-vehicle large truck roadway departure crashes where the truck driver survived may not be applicable to crashes which do not tit this description.

Also, it is unclear what should be counted as a fatigue-related crash. Clearly all crashes where fatigue is cited should be included, but there are other crashes where fatigue may play a less direct role. Crashes involving inattention, distraction, or other driver failures may be related to fatigue, as a sizeable literature demonstrates that fatigued individuals are prone to a variety of mental and physical errors. Pilcher's meta-analysis of 19 studies reveals that "sleep deprivation has a significant effect on human functioning", with cognitive performance subsiding more than physical performance. This supports Brown, who argues that "the main effect of fatigue is a progressive withdrawal of attention from road and traffic demands". This suggests that in some cases, mental errors cited on a PAR may be the result of fatigue. Dinges supports this logic, stating that "A loss of 10 percent in the detection of salient visual stimuli (e.g., 'slow speed' signage) and a 10 percent increase in reaction time (e.g., stopping to avoid a rear end collision) both of which can be demonstrated in even moderately sleepy persons (Dinges 1992) may contribute to many traffic and work accidents that are otherwise attributed to operator inattention".

Not only does fatigue demonstrably diminish individuals performance, but the type of errors made by fatigued drivers are a major causal factor in crashes. For example, the classic Indiana Tri-Level Study of the Causes of Traffic Accidents (Treat et al.), perhaps the most in-depth study ever performed in the

US on crash causation, found that “recognition failure” was involved in 56% of the crash cases analyzed. While driver drowsiness/fatigue was found to be a certain or probable factor in only 2% of the cases, 23% involved faulty visual surveillance, 15% involved inattention, and 13% involved distraction. More recent studies have also found high levels of inattention and distraction. In a study of nearly 700 Crashworthiness Data System (CDS) and GES crashes, Najm et al determined that recognition errors were the primary causes of 45% of the cases studied, compared to 3.7% primarily due to driver drowsiness (Najm et al). General Motor scientists reviewed over 1,000 PARs from Michigan, and reported that 17% were attributable to “daydreaming” and 18% to improper lookout, with just 1% due to “dozing” (Deering). While these studies were not limited to CMV crashes, they demonstrate the prevalence of mental errors in crashes.

A recent study by the US Coast Guard also suggests that direct measurement of fatigue may understate its true extent. Coast Guard researchers developed a “fatigue index”, based on the number of fatigue symptoms reported, and the number of hours worked and slept in the 24 hours prior to the incident. Using this formula upped the percentage of critical vessel cases categorized as fatigue related from 1.2 percent to 16 percent. For critical casualty cases, the fatigue index resulted in an adjustment from 1.3 to 33 percent. These reports indicate the need to be expansive in defining fatigue related incidents, and the likelihood that measurements of fatigue based solely on accident reports are likely to underestimate the extent of fatigue (US Coast Guard).

The FHWA recently completed an analysis of large truck crashes related primarily to driver fatigue, a copy of which has been placed in the docket. This analysis reviewed existing studies of fatigue related crashes, by a variety of characteristics, including vehicle body type and crash severity. Table 13, reprinted from that study, shows that based on PARs, 1.98% of all fatal large-truck involved crashes were clearly indicated to be fatigue-related. Fatal to truck occupant only (FTO) crashes were much more likely to be fatigue-related, and crashes fatal to non-truck occupants were significantly less likely to have fatigue cited as a related factor. For all severity levels, tractor-trailer combinations had a higher rate of fatigue-related crashes than single-unit trucks.

Table 13
Large Truck Crashes and Percentages Associated with Truck Driver Fatigue,
1992-1997 Average Annual Crashes and Percentages

	Single-Unit Trucks		Combination-Unit Trucks		All Large Trucks	
Crash Type	Annual Crashes	% Fat Related	Annual Crashes	% Fat Related	Annual Crashes	% Fat Related
All Police Reported	165,000	0.17%	231,000	0.49%	392,000	0.36%
All Fatal	1,117	0.96%	3,190	2.30%	4,296	1.98%
Fatal to Truck Occupant Only	164	3.94%	418	12.99%	580	10.57%
Fatal to Non-truck Occupant	978	0.45%	2,828	0.69%	3,666	0.62%

The authors then reviewed other fatigue studies of a variety of crash types, including passenger vehicle only crashes, all vehicle crashes, and single vehicle truck only crashes. They also examined an NTSB report and more detailed NHTSA crash data. Based on this review, they estimate that fatigue incidence from PARs should be adjusted by a correction factor of 1.4 to 3.1 times the PAR reported fatigue rate, varying with the crash severity and vehicles involved. Table 14 shows the range of adjustment factors by vehicle and crash type.

Table 14
Estimated Ranges for Percentages of the Large Truck Crashes that are Fatigue-Related

Crash Type	Single-Unit Trucks	Combination-Unit Trucks	All Large Trucks
All Police Reported	0.24% to 0.53%	0.69% to 1.5%	0.50% to 1.1%
All Fatal	1.3% to 3.0%	3.2% to 7.1%	2.8% to 6.1%
Fatal to Truck Occupant Only	5.5% to 12%	18% to 40%	15% to 33%
Fatal to Non-truck Occupant	0.63% to 1.4%	0.97% to 2.1%	0.87% to 1.9%

The numbers range widely, from a low of .24% for all police-reported single-unit truck crashes to a high of 40% of all fatal to truck occupant only tractor-trailer combination crashes. The midpoint estimate for all fatal truck crashes is 4.45%.

These data provide an overview of the magnitude of the fatigue problem, and demonstrate the substantial differences in estimates of the size of the problem. In order to analyze the impact of these proposals, the data must be broken down so that they are consistent with the regulatory categories envisioned in this proposal.

2) Trucks Involved in Fatal Accidents Analysis

The only crash data file suitable for detailed analysis by truck trip characteristics is the Trucks Involved in Fatal Accidents (TIFA) tile, maintained by UMTRI. In addition to the FARS variables, TIFA has more complete and accurate data on truck types, area of operation (interstate, intrastate), and carrier type (private, for-hire). Since 1994, TIFA has also included a trip type variable based on the one-way intended trip distance (local delivery, 51-100 miles, 101-200 miles, 201-500 miles, over 500 miles) used in the 1992 Truck Inventory and Use Survey. Prior to 1994, TIFA included a more limited definition of trip distance, with the longest distance allowed as 200 or more miles.

It is impossible to precisely determine the operational type of all trucks involved in fatal crashes. Presumably some TIFA-defined local trucks would tit the NPRMs definition of work truck or bus, and vehicles in the other category may be either local, work truck or bus, or even regional. We were unable to precisely match the definitions in the proposed rule; this is the closest approximation possible with the crash data. The breakdown of crashes (and crashes avoided) by operational type may differ from the true rate for these types. While there may be some error in the distribution of crashes we do not believe this markedly affects the results. This uncertainty will not affect the total number of crashes or the number of fatigue-related crashes.

Most of the following results are based on a 6-year TIFA tile, 1991-1996. The coding on fatigue is taken from the "driver related factors" variables in FARS. Up to 3 factors can be selected from a list of nearly 100 choices covering the broad categories of physical/mental condition, vision obscured, avoiding or swerving, and miscellaneous. "Drowsy, sleepy, asleep, fatigued" is the first factor listed (01). For this analysis, the truck driver is classified as fatigued if 01 is coded for any of the three contributing factors for the truck driver. For most cases, no driver related factor is coded. "None" is coded about 60 percent of the time for the first driver related factor, 80 percent for the second factor, and 95 percent for the third.

FARS analysts must rely on the original police accident report To the extent that the reporting of fatigue varies from state to state, it is probably a reflection of the availability of coding or information on the original police report. In general, the FARS data are very accurate and complete. Fatigue, of course, is particularly difficult to assess, even with in-depth investigations, since there is no physical evidence of fatigue. The assessment is usually based on statements of the involved parties or witnesses, or inferred from the sequence of events.

A review of the file shows large State variations. North Carolina, Wisconsin, New Hampshire, the District of Columbia, and Hawaii reported no fatigue cases between 1991 and 1996. More significantly, 5 large states, shown in Table 15, reported a total of only 9 fatigue cases in 6 years, or 0.2 percent of the truck drivers involved in fatal crashes in these states (based on all crashes). This percentage is below the national average of 1.86 percent by nearly a factor of 10. The FMCSA believes that fatigue is under reported in these states. These states represent 20 percent of the national total, suggesting that the national average is also higher than reported.

Table 15
States Reporting less than 0.5% Fatigue
TIFA 1991-1996

State	Fatigue	Total	percent
Florida	5	1648	0.3%
Michigan	3	879	0.3%
North Carolina	0	1115	0.0%
Ohio	1	1167	0.1%
Wisconsin	0	573	0.0%
Total	9	5382	0.2%

A second group of 10 States reported between 0.5% and 0.7% fatigue. However, these States represent only 10 percent of all fatal crashes, and therefore have less influence on the national totals. Thirty six States, accounting for 70 percent of fatal truck crashes, reported at least 1% fatigue crashes. The average level of fatigue reported in these States is 2.5 percent, 35 percent higher than the overall figure.

Arizona, Maine, and Texas reported the highest level of fatigue-related crashes, as shown in the following table. It is not clear why their rates are so much higher than the national average.

Table 16
States Reporting the Most Fatigue
TIFA 1991-1996

State	Fatigue	Total	Percent
Arizona	31	435	7.1%
Maine	9	119	7.6%
Texas	117	2150	5.4%

Fatigue reporting appears to be higher in western States. However, this result is influenced by the State to State variations mentioned above.

Table 17
Fatigue by Geographic Region
TIFA 1991-1996

Region	Fatigue	Total	Percent
Northeast	131	9869	1.3%
Southeast	67	6609	1.0%
Northwest	50	2447	2.0%
Southwest	262	8487	3.1%
AK&HI	1	51	2.0%
Total	511	27463	1.9%

We also examined fatigue reporting in crashes with one or more fatality in the truck. Overall, 14 percent of all trucks involved in fatal crashes had one or more fatalities in the truck. Of the truck occupant fatalities, 9.5 percent (361 cases) were coded for truck driver fatigue. These fatigue cases are 70 percent of all fatigue cases coded for truck drivers in the TIFA data from 1991 to 1996. The proportion of fatigue in the non-truck fatalities is 0.6 percent. These figures are similar to those reported in table 13. Again, the variation by state is substantial, with the same approximate order of states as found for all truck involved crashes. The range of percentages is substantially higher, with several states reporting over 20 percent fatigue in truck driver fatalities-and a few reporting 40 percent.

The variation in fatigue reporting provides further evidence of the difficulty in determining the true rate. As noted above, most analysts agree that the actual rate is greater than the 2 percent reported on police accident forms Nonetheless, this evaluation uses rates from TIFA to categorize risks by operation types. We then adjust the TIFA-reported values to more plausible figures, using the percent distributions by operational type and hours driving.

Overall

Between 199 1 to 1996, fatigue was coded as a contributing factor for 5 11 truck drivers out of a total of 27,463 medium and heavy trucks involved in fatal accidents. The 5 11 cases of truck driver fatigue coded correspond to an annual average of 85 trucks per year, 1.9 percent of the 4,577 the medium and heavy truck drivers involved in fatal accidents annually.

The data were analyzed at the truck level, counting the number of trucks involved in fatal crashes rather than the number of crashes or fatalities. Between 1988 and 1997, the ratio of fatalities to trucks involved in fatal crashes has remained constant at 1.1, and the ratio of fatal crashes to trucks was .9397. Therefore, we multiplied the truck figures in table 18 by 1.1 to obtain estimates of the number of fatalities by operational type, and by .9397 to estimate crashes. The percentages stayed the same, since trucks involved in both fatigue and non-fatigue related crashes were multiplied by the same constant. Accordingly, TIFA indicates that there are approximately 80 fatigue-related crashes involving 85 trucks and resulting in 94 fatalities per year Numbers do not sum precisely because of rounding.

Table 18 shows that the risk of fatigue increases with trip distance. Long-haul trips, defined here as those with an intended trip distance of over 200 miles, account for one third of all fatal truck crashes, but two thirds of all fatigue-involved truck crashes (excluding crashes where the distance is unknown). The relative risk of fatigue-related crash - that is, the probability of fatigue given that a truck is involved in a fatal crash - is twice that of all vehicles. For trucks on trips of 500 miles or more, the relative risk is even higher, at 2.35. This suggests, not surprisingly, that when a fatal truck crash occurs, drivers engaged in long distance travel are more likely to be cited for fatigue. Investigating officers are unlikely to know the intended trip distance when completing the PAR, which suggests that this reflects a true difference in fatigue, rather than an artifact of police reporting.

Table 18
Fatality and Fatigue Crash Data
TIFA 1991-1996

	Local, < 50 miles	Other	Long Haul >200 miles	Unknown	Total
Trucks in Fatal Crash	1,810	997	1,419	351	4,577
Fatalities	1,991	1,097	1,561	386	5,035
Crashes	1,701	937	1,333	330	4,301
Percent Fatalities	39.6%	21.8%	31.0%	7.7%	100%
Trucks whose Drivers were Coded for Fatigue	7	19	54	5	85
Fatalities where Driver was Coded for Fatigue	8	21	60	5	94
Crashes where Driver was Coded for Fatigue	7	18	51	5	80
Percent Fatigue-Coded Fatalities	8.0%	21.9%	63.3%	6.5%	100%
Relative Risk	0.2	1.0	2.0	0.8	1.0

Other research also indicates that local drivers are less likely to be involved in a fatigue-related crash than their long-haul counterparts. An analysis of the fatal crash rate and mileage figures from TIFA and the 1992 TIUS shows a dramatic difference in the accident experience of local and other trucks. Local, single-unit straight trucks had an average of 0.0022 fatigue-related fatal involvements per 1000 registered trucks. The comparable figure for long-haul tractor-trailers was 0.078 1, approximately 35 times greater. On a per mile basis, long-haul trucks were almost 20 times more likely to be involved in a fatigue-related crash. (Massie et al).

Massie et al's figures indicate a higher discrepancy between local and long haul drivers accident experience than does the FMCSA analysis. In table 18, the FMCSA shows that local trucks have about one-tenths the accident experience of long-haul trucks (defined as crashes with an intended trip distance of more than 200 miles), whereas Massie indicates that long-haul trucks have a crash experience 20 to 35 times greater than their local counterparts, depending on the metric. These differences are partly due to the different data used and mostly a result of different definitions of local and long-haul trucks. Massie et al only include single unit class 3, 4, and 5 vehicles with a primary area of operation of less than 50 miles, while the FMCSA includes all vehicle types and classes with a primary area of operation of less than 50 miles. Clearly, the data indicate that whatever definition is used, local drivers are significantly less likely than others to be involved in a fatigue related crash.

Between 1988 and 1997, 20.5 trucks were involved in injury crashes for every truck involved in a fatal crash, and there were 26 injuries for every fatality. There were also 0.686 injury crashes for every injury, which translates into 1.46 injuries per injury crash. We assume these ratios are similar for fatigue-related truck-involved injuries. Table 19 shows the Agency's preliminary estimate of the number of trucks involved in fatal and injury fatigue-related crashes, by operational type. Sums do not add because of rounding.

Table 19
Annual Trucks Involved in Fatigue-Related Fatal and Injury Crashes
TIFA 1991-1996

	Local, < 50 miles	Other	Long Haul, > 200 miles	Unknown	Total
Trucks, Fatalities	7	19	54	5	85
Trucks, Injuries	140	383	1,110	113	1,746
Trucks, Total	147	402	1,164	118	1,831
Fatalities	8	21	59	7	94
Injuries	196	536	1,555	158	2,444
Total	204	557	1,614	165	2,538

Most analysts believe that the incidence of fatigue-related fatal crashes is higher than the 2% figure from the PARs, and many would put the true figure well above the 2.8 to 6.1% range presented in table 14. As noted above, fatigue increases the likelihood that drivers do not pay sufficient attention to driving or commit other mental errors. As discussed on pages 22 and 23, in-depth studies of crashes have found that inattention and other mental lapses contribute to up to 50% of all crashes. While fatigue may not be involved in all these crashes, it clearly contributes to some of them. We estimate that 15 percent of all truck involved fatal crashes are "fatigue-relevant", that is, fatigue is either a primary or secondary factor. This includes the 4.5% of fatal crashes where fatigue is directly involved, and another 10.5% where it contributes to other mental lapses, which then result in a crash. The FMCSA conducted some sensitivity analysis to determine the impact of different baseline levels of fatigue.

Table 20 presents the FMCSA's estimate of the baseline number of fatalities and injuries in truck-involved fatigue-related crashes. The Agency made 2 changes to the data presented previously: we redistributed the baseline number of crashes to eliminate the unknown category, and we redistributed long-haul crashes. Crashes where the intended one-way trip distance was unknown were assigned to other categories based on those categories percent of all crashes. If 25 percent of all fatigue-related crashes were long-haul, we assumed that 25 percent of the unknown crashes were also long-haul. We also split long-haul crashes into long-haul and regional. As noted previously, long-haul crashes were defined as those where the intended trip distance was 200 miles or greater. This was acceptable for the options which treat long-haul and regional drivers essentially the same. However, option 4 makes a significant distinctions between these types of drivers, requiring long-haul but not regional drivers to use an EOBR. Because this would yield a differential safety impact on these types of drivers, we estimated the percent of over 200 mile crashes which belong in each category

Prior to 1994, the largest acceptable intended trip distance response was 200 or more miles. Beginning in 1994, TIFA includes a category for an intended trip distance of 500 or more miles. Between 1994 and 1996, 58 percent of all fatigue-related crashes with a trip distance of more than 200 miles were also over 500 miles. Accordingly, we assumed that 58 percent of the crashes labeled as long-haul above were truly long-haul, and 42 percent were regional

Table 20 shows the FMCSA's revised estimate of the number of fatigue-related crashes by operational type.

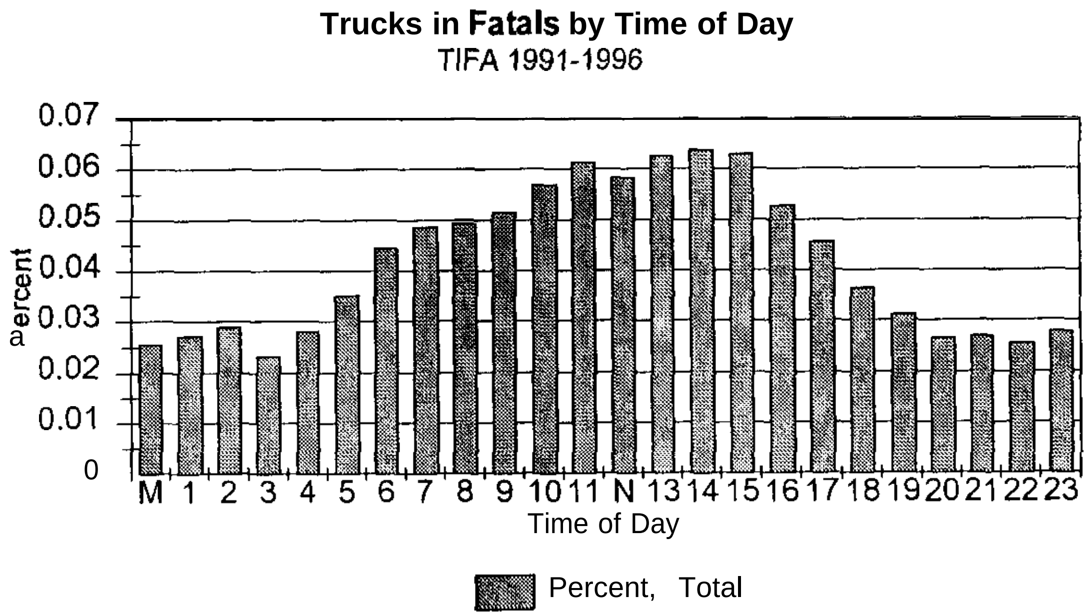
Table 20
Revised Annual Number of Fatalities and Injuries

	Other	Regional	Long Haul	Total
Fatalities	242	215	298	755
Injuries	6,307	5,613	7,785	19,705
Fatal Crashes	207	184	254	645
Injury Crashes	4,327	3,851	5,341	13,519
Total	4,534	4,035	5,595	14,164

Time of Day

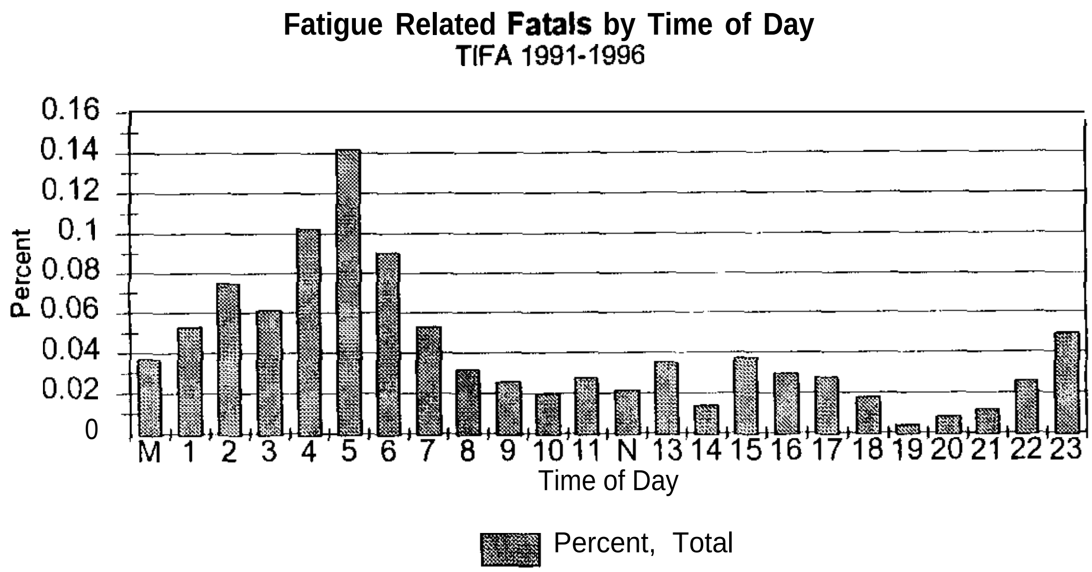
Without reliable exposure data disaggregated by type of operation, it is impossible to confirm that truck travel matches the crash distribution. UMTRI analyzed the relationship between the risk of fatigue given a fatal accident involvement and the risk of fatigue per VMT, by truck body type and trip type, using VMT data from the TIUS. This analysis, which is partially reprinted in Appendix B, suggests that the relative risk of fatigue given a fatal accident involvement is a good predictor of the risk of fatigue per VMT. This is important because exposure data is not available for many relevant variables (such as time of day and hours driving).

Chart 1, which shows the distribution of trucks involved in fatal crashes, most likely mirrors truck traffic, with a mid afternoon peak when truck travel is believed to be highest. Chart 2 shows the distribution of fatigue involvement, which is quite different than overall involvement in crashes. Fatigue peaks between 4 and 6 AM. Chart 3 combines data from both previous tables to show the relative risk of a fatigue involvement, given that a fatal crash occurs. This chart closely resembles the preceding chart, indicating that the incidence of fatigue is more variable than that of crashes.



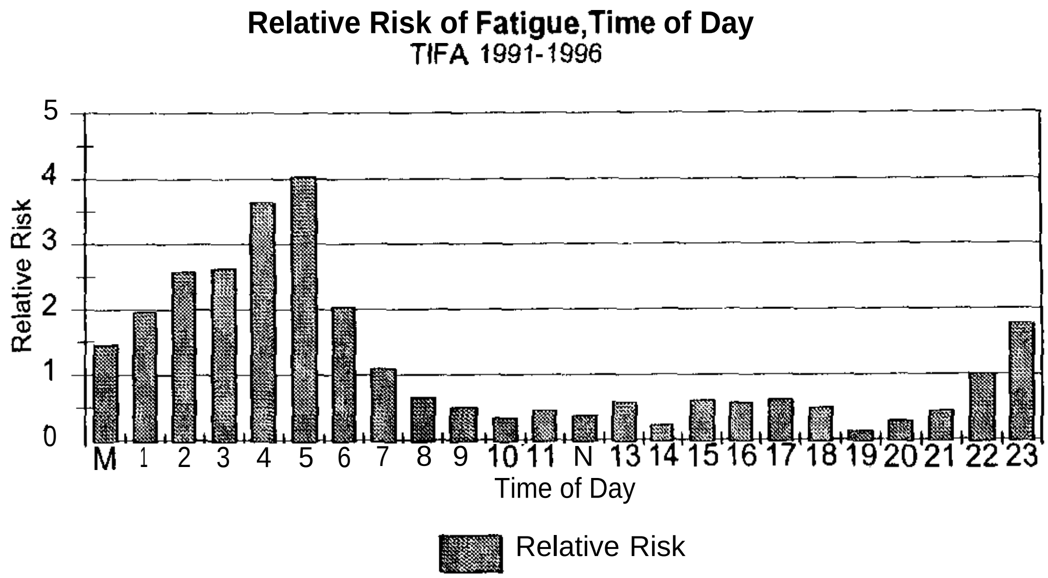
Trucks in Fatals by Time of Day
TIFA 1991-1996
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Percent
M 1 2 3 4 5 6 7 8 9 10 11 N 13 14 15 16 17 18 19 20 21 22 23
Time of Day
Percent, Total

Chart 2



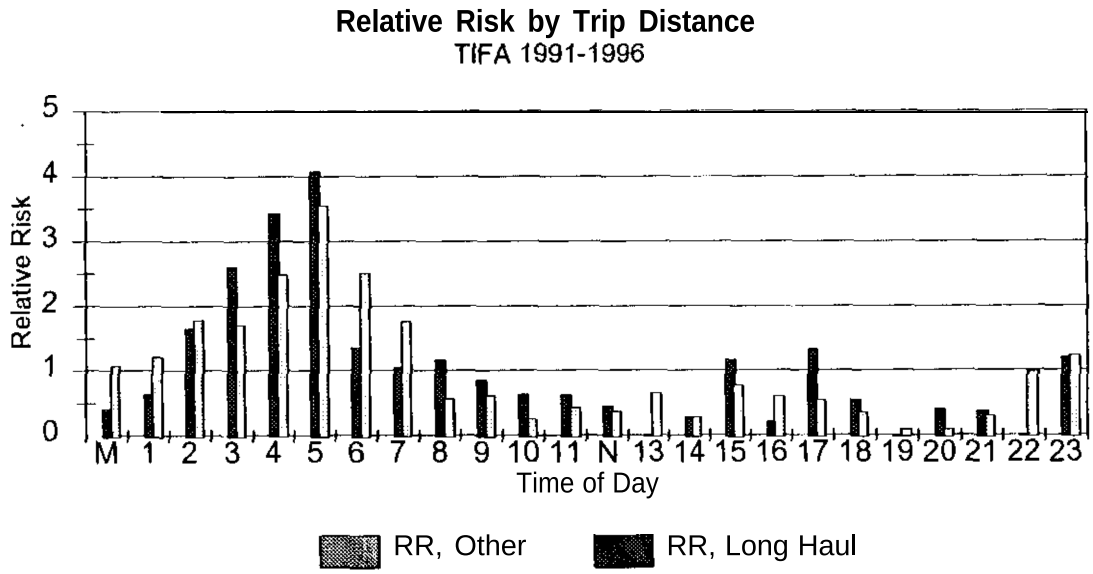
Fatigue Related Fatals by Time of Day
TIFA 1991-1996
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Percent
M 1 2 3 4 5 6 7 8 9 10 11 N 13 14 15 16 17 18 19 20 21 22 23
Time of Day
Percent, Total

Chart 3


Relative Risk of Fatigue,Time of Day
TIFA 1991-1996
Relative Risk
5
4
3
2
1
0
M 1 2 3 4 5 6 7 8 9 10 11 N 13 14 15 16 17 18 19 20 21 22 23
Time of Day
Relative Risk

Relative risk looks the same for both long haul and other trucks. Chart 4 shows that both types of operations have peak relative risks between 4 and 6 AM. Fatigue is coded as a factor for approximately 5 local operations trucks per year, resulting in wild swings in relative risk values. Accordingly, local operations were not included in this chart

Chart 4



There is no significant difference between the time of day distribution of straight and combination trucks

Hours Driving

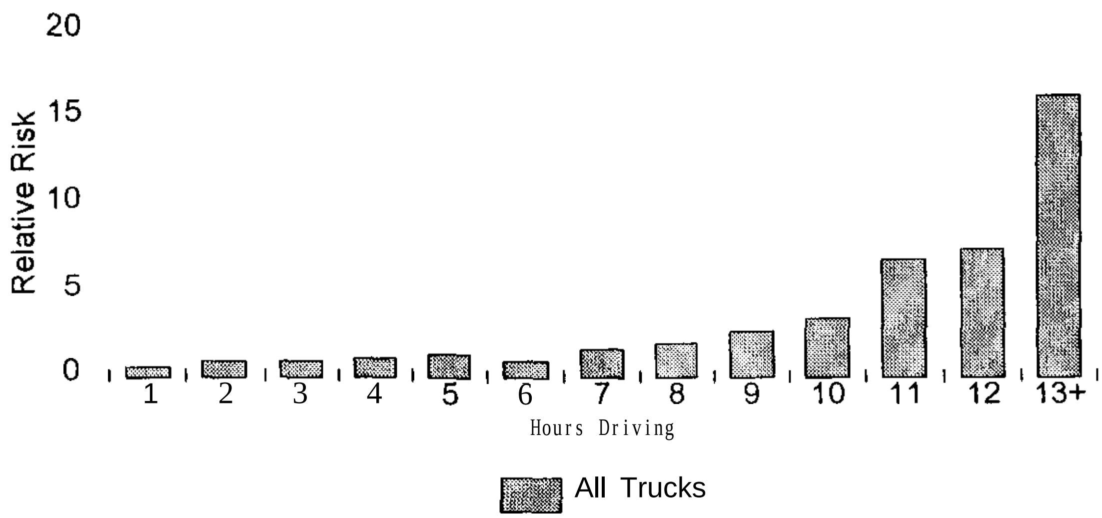
Chart 5 shows the relative risk of a fatigue related fatal crash by the number of hours of driving. Through 1992, data on hours driving came from phone interviews and the MCS 50-T forms that motor carriers involved in certain accidents were required to complete. Since 1993, data on hours driving come entirely from phone interviews by UMTRI researchers. The interview source is the owner of the truck, so we expect some underreporting for hours above the legal limit. About one quarter of all respondents refuse to answer this question, much higher than the percent missing for any other question. Nonetheless, the data clearly show the impact of extra hours driving on the likelihood of fatigue being cited in a crash.

Not surprisingly, risk increases with time driving. The relative risk is about 7 times normal between the eleventh and twelfth hours of driving, then jumps to more than 16 times normal at more than 13 hours. However, this is based on extremely small numbers - there are approximately 5 fatal crashes per year where fatigue is coded as a factor and the driver has been behind the wheel for 13 or more hours, out of a total of about 18 fatal crashes. There also appears to be a slight increase in the risk of fatigue-related crashes at 5 hours. This is difficult to discern in the following chart, but becomes apparent when looking at risks for long haul drivers. Jovanis et al. found a similar pattern in their examination of crashes from one long-haul carrier, including both a bump at 5 hours and a more dramatic and consistent increase in crash risk after 8 hours (Lin et al.).

Chart 5

Relative Risk of Fatigue Crash

by Hours Driving, TIFA 1991-1996



As noted above, long haul trucks are involved in about 67% of all fatigue-related truck crashes. These vehicles also have a greater relative risk of fatigue involvement for almost any given number of hours driving. The previous chart would not appreciably change if vehicles were broken down by trip type, except when hours driving exceed 11, where the small numbers of crashes yield some extremely high relative risk values.

The distribution of crashes by vehicle type is not so clear cut. Two-thirds of all trucks involved in fatal crashes between 1991 and 1996 were combination vehicles, including both tractor semi-trailers and straight trucks pulling a trailer. These vehicles were also involved in four-fifths of all fatigue-involved fatal crashes, only modestly higher than their percentage of all fatal truck crashes. This suggests that truck body type is a weak predictor of fatigue.

Long haul combination vehicles account for about half of all fatal CMV crashes, but three fourths of all trucks in fatigue-involved fatal crashes. Straight trucks in long haul operations are more likely to be fatigue involved although they represent just 7 percent of trucks involved in fatal crashes, they account for 14% of fatigue involved trucks. The relative risk for drivers of these vehicles is almost 2, while it is closer to 1.5 for drivers of combination vehicles in long haul operations. This over-representation may be partly due to drivers of straight trucks being unaccustomed to the rigors of long haul operations.

Injury Crashes

Data on non-fatal crashes are even more limited than for fatals. All the factors militating towards underreporting of fatigue in fatal crashes are even more prevalent in non-fatals. In addition, because the best estimate of the number of non-fatal truck involved crashes is based on an sample rather than a census (as is the case with fatal crashes), we are not able to segregate these crashes by operation type. Therefore, for this analysis, we use the ratio of all injury crashes to fatal crashes as a proxy for fatigue-related injury crashes. We have also assumed that injury crashes follow the same patterns as fatal crashes, with overall crashes higher in the afternoon and fatigue-related crashes peaking between 4 and 5 AM.

To evaluate the consistency between fatal and injury crashes, we examined injury crash data from Texas. We chose to review Texas for a number of reasons. First, it typically ranks number 1 or 2 in terms of fatal truck crashes, ensuring that we would have a large sample to analyze. Second, Texas reports a high proportion of fatigue in fatal truck crashes, which suggests the State is good at reporting fatigue. This analysis shows that injury crashes generally mirror the fatal crash distribution by time of day. No data are available on injury crashes by hours driving. We have assumed that the distribution of injury crashes, both overall and fatigue-related, follow the pattern exhibited by fatal crashes. This analysis has been placed in the public docket.

This analysis does not include property damage only (PDO) crashes. The FMCSA was unable to find any reliable information on PDO crashes by trip distance, hours driving, or time of day. We also believe that fatigue-related crashes tend to be more severe than non-fatigue-related crashes, so the number of fatigue-related PDO crashes is probably small. In any case, the damage from PDO crashes, whether fatigue related or not, is by definition minimal. In a previous analysis, the FHWA estimated that the average truck involved PDO crash costs society between $5,000 and $10,000. To the extent that a sizeable number of PDO crashes which would be affected by this proposal, overall benefits would be greater than the Agency's estimate.

Chapter 4
Benefits

Background

The purpose of this proposal is to lower the number of fatigue-related crashes. While the FMCSA believes that any of these proposals would have the desired effect, the magnitude of any reduction is extremely difficult to predict with confidence, for a number of reasons. First, as explained previously, the baseline number of fatigue-related crashes is uncertain. Estimates vary widely, depending on the definition of fatigue and the data source used. Second, we do not know how carriers, drivers, and others will respond to the regulatory changes envisioned in the proposals.

Finally, even if we were certain about the baseline number of crashes, drivers schedules, and the reaction of drivers and carriers to new regulations, it is still extremely difficult to estimate precisely the reduction in fatigue-related crashes. The expert panel (and most researchers) agree that increasing the time available for sleep will lessen fatigue, and thereby diminish the number of crashes. There is little certainty, however, about the magnitude of this change. Because of safety concerns, there is no direct experimental evidence with which to gauge a possible relationship. Because accidents are statistically quite rare, some of the smaller scale studies do not provide enough reliable data to use for predictive purposes. Consequently, much of the driving-task-relevant supporting evidence for the proposals is indirect, using industries other than trucking or measures believed to be related to crashes.

The analytical difficulties are even more vexing because a large number of other variables will change, which further clouds efforts at prediction. Drivers would be allowed to drive fewer hours per 24-hours, time available for sleep will increase, cumulative multi-day duty time would change, and schedule regularity might increase, to name a few of the possible changes. The impact of any one of these changes is subject to uncertainty; their combined impact is even less clear. There may be interactive as well as individual effects.

Untangling the effects of multiple changes is always difficult, and can usually only be confidently done when sufficient detailed and reliable empirical data exist. While studies have examined specific components of the proposed changes, the studies disagree in key parameters, and none of the studies investigates the combined impacts of the sorts of changes envisioned in this proposal.

For example, while researchers appear to agree that overall, crash rates increase with time spent driving, there is no consensus on either the magnitude of the increasing risk, or the point at which the risk begins to rise. Folkard reviewed a number of studies of transport safety and crash risk in a recent article in the Journal of Accident Analysis and Prevention. He analyzed 3 studies of road safety incidents which controlled for driving time, and combined the data from these studies for further analysis. Folkard noted several interesting patterns. First, the relative risk of a crash was higher in the first 4 hours of driving than in the second 4 hours. Risk decreased by about 30% from the first to the second 4 hours on duty.

According to Folkard, "...only when duty periods are extended to 14 hours or more will the overall risk exceed that on 4 hour duties". Second, Folkard indicates that the relative risk of a crash is relatively stable between 8 and 10 hours on duty, and then rises slowly. At 11 hours, the relative risk of a crash (compared to 8 hours on duty) is about 1.03, at 12 hours it is 1.06, at 13 hours is 1.13, and at 14 hours it is 1.22.

On the other hand, Jovanis and Lin argue that the crash rate increases consistently from the first hour driving. Using detailed information from one national LTL carrier from 1984, they estimated the likelihood of an accident after specific time driving, given that the driver does not have a crash in earlier time periods (Jovanis, 1984). Jovanis et al. found that the first four hours have the lowest accident risk Crash risk rises by 65% through the seventh hour, and then 80% and 150% by the eighth and ninth hour. While the data seem to suggest that the risk increases after 9 hours of driving, the authors cautioned that there was not enough data on trips of over 9 hours to allow for reliable estimation.

Jovanis et al. also estimated the impact of drivers' multiday driving patterns. They found a risk 1.5 times higher than the baseline crash rate for a variety of driving patterns. Jovanis et al. define patterns according to most common hours of the day driving, the regularity of the driver's schedule, and the frequency of driving. Therefore, we are unable to transform these patterns into values useable for this regulatory evaluation. Nonetheless, these results support the expert panel's and Agency's belief in the importance of drivers' cumulative driving times.

Crash Reduction

This evaluation assumes that options 1 and 2 would lower crashes by 5 percent, and option 3 by 7.5 percent. We further assume that, when fully phased-in, option 4 would lower crashes by long-haul drivers by 20 percent, and by all other drivers by 5 percent. Option 5 is assumed to lower crashes by long-haul and regional drivers by 20 percent when fully phased-in, and by all other drivers by 5 percent.

The Agency estimates that motor carriers will phase-in use of EOBRs in equal increments over the entire phase-in-period, with 1/x of EOBRs installed per year, where x equals the phase-in-period. Within one year of promulgation, ½ of large motor carriers' vehicles and drivers will use EORBs, 1/3 of medium motor carriers, and 1/4 of small motor carriers. Benefits were phased-in in conjunction with EOBR use. The estimated baseline crash reduction from the regulatory changes is 5 percent, while the reduction for motor carriers using EOBRs is 20 percent. This evaluation added in the fifteen percent increment (20 percent minus 5 percent) over 1/x years for each size of motor carriers. For the first year of this rule, crashes by large long-haul motor carriers would fall by 12.5 percent, for medium motor carriers by ten percent, and for small motor carriers by 8.5 percent.

Because options 1 and 2 are so similar, no attempt was made to differentiate between their safety impacts. Option 3 includes the provisions of options 2, plus the additional limitation on nighttime driving We have implicitly assumed that the nighttime driving limits alone lowers crashes by 2.5%. We assumed that options 4 and 5 would have a significant impact on the crash rate of drivers who use an EOBR. Table 21 displays the assumed crash reduction level for each option

Table 21
Assumed Fatigue-related Crash Reduction

Option	Reduction in Fatigue-related Crashes
1	5%
2	5%
3	7.5%
4	20% for long-haul category crashes, 5% for all other category crashes
5	20% for long-haul and regional category crashes, 5% for all other category crashes

The crash reduction impacts are obviously uncertain, because of the absence of reliable empirical data. Nonetheless, we believe that by allowing drivers longer consecutive off-duty periods to obtain sleep, these proposals should reduce fatigue-related crashes. Evidence suggests that many CMV drivers are not getting sufficient sleep. Insufficient sleep leads to degradations of cognitive performance, including increased mental errors, lapses in vigilance, slower reaction time, and errors in judgement. These errors in turn heighten the likelihood of crashes. The proposal would all allow drivers larger continuous time off periods, which is associated with increased sleep time. These statements will now be discussed in turn.

Many CMV drivers are not obtaining sufficient sleep. The UMTIP driver survey differentiates between drivers surveyed at a truck stop and those surveyed at home. Twenty five percent of drivers interviewed at a truck stop reported 7 or fewer hours of sleep in the last 24 hours, and forty percent of those interviewed over the phone reported seven or fewer hours of sleep during the last 24 hours the driver worked. Ten percent of the truck stop interviewees and 23 percent of the telephoned interviewees reported five or fewer hours of sleep. Drivers in Wylie et al. obtained an average of 5.2 hours of sleep per sleep period, 2 hours less than their stated ideal.

Insufficient sleep leads to a degradation of performance and increased mental errors. A substantial research literature documents the deleterious effects of fatigue on overall performance. Some of that research is reviewed in chapter 2 of Wylie, et. al. In their review of the literature in 1988, Wylie and Mackie concluded that the adverse behavioral effects of fatigue include increased lapses of attention, increased operational error and distractability, reduced rate of information processing, more variable task performance, and reduced reserve capacity. Johnson et al. show that reaction time and lapses increase as sleep time decreases, while simulator-based research shows that crashes, lateral placement variance, and lane excursions increase with progressive sleep deprivation (Peters et al.). Finally, a meta-analysis of 19 original research studies reported that sleep deprivation has a significant impact on human and cognitive performance, motor performance, and mood, with the mean level of functioning for sleep-deprived subjects equal to the 9th percentile of non-sleep-deprived subjects (Pilcher et al.).

Degradation of performance and mental errors increase the likelihood of crashes. As discussed on page 21, inattention and mental errors contribute to a significant number of crashes. While some crashes may be entirely random and unavoidable, in the majority of cases the occurrence of a crash implies that a mental lapse was experienced. Therefore, most researchers believe that degraded performance and increased occurrence of mental errors increases the likelihood of involvement in a crash.

Increased continuous time off is associated with increased sleep time. The proposals under consideration would increase the amount of continuous off-duty time available to drivers. Wylie et al showed that longer periods off-duty are correlated with longer sleep periods. Several other studies have reported similar results (Mitler et al.; Kurumatani et al.).

Some explanation is due for the modest estimated reduction of option 3, which limits nighttime driving. Chart 4 showed that the relative risk of fatigue-related crashes is higher during the night than at other times of day, and Wylie et al demonstrate that time of day was the strongest factor influencing fatigue and alertness. The expert panel argued that not only is the risk of fatigue-related crashes higher at night, but that the overall crash risk is elevated during these hours. While mileage data that would allow for definitive calculations of the overall crash rates by time of day are not available, it is clear that both fatigue propensity and the risk of fatigue-related crashes peak at night. Reducing this high risk travel should have a substantial impact on crashes.

However, the ultimate safety impact would largely depend on how motor carriers adjust their nighttime operations. Motor carriers could comply with this option in a number of ways: shifting traffic to daytime, hiring additional nighttime drivers, rotating existing drivers' schedules, or, most likely, using some combination of these options. Each of the alternatives may pose a safety downside.

The preferred solution from a safety perspective might be to hire additional drivers. However, it is unclear that a significant pool of drivers available for nighttime driving exists. Motor carriers and the trade press have argued that there is a substantial shortage of qualified truck drivers (Transport Topics Online, Traffic World), which has been exacerbated by the current historically low unemployment rates. Some analysts, including the US Department of Commerce's International Trade Administration, concur with this assessment (McGraw-Hill and US Department of Commerce). Other analysts assert that motor carriers' driver problems are the result of high turnover rates rather than a shortfall in the number of drivers (Engel; Gallup Organization). In any case, new hires may not operate as safely as existing drivers. As the eligible pool of drivers is exhausted, motor carriers may find themselves forced to hire drivers they previously would not have employed. Presumably, some of these new hires will have less desirable human capital characteristics than current drivers. Their human capital deficit, which could be physical, cognitive, or emotional, may have adverse safety impacts.

Shifting freight to daytime or rotating drivers current schedules may also have a safety downside. The most significant problem would occur if drivers alternated between daytime and nighttime driving. This would disrupt drivers' circadian rhythms, since they would not have a consistent start or stop time. The expert panel believes that regularity of sleep/wake cycles is one key to safe driving, but an alternating day/night schedule would eliminate regularity for those drivers.

Shifting traffic to early morning would increase congestion during an already busy times of day. While there would probably be an overall reduction in crashes, the extra traffic during an already congested time of day would likely result in an increase in daytime crashes. While the higher relative risk of a fatigue-related crash at nighttime (Chart 3) suggests that daytime travel is safer, there would undoubtedly be some increase in daytime crashes commensurate with the increased traffic. While the overall number of fatigue-related crashes would likely fall somewhat, the number of fatalities and injuries per fatigue-related crash might increase. We noted above that it is the truck driver who is the fatality in approximately 70% of crashes for which truck drivers are coded as fatigued. This is partly due to the fact that truck drivers are most likely to be driving in a fatigued condition during the part of the night that other drivers are least likely to be on the road. By increasing the amount of driving during hours when total vehicle traffic is higher, the smaller number of CMV crashes that may occur are more likely to involve occupants of the other vehicle. This may somewhat offset the reduction in the total number of fatigue-related crashes.

Additional truck traffic on already congested roadways could also increase pollution, as truck idling times could increase and overall speeds fall to less efficient levels. The FMCSA did not estimate the costs of any additional pollution generated by added daytime traffic.

Options 4 and 5 have the most dramatic safety impact, with an assumed 20 percent reduction in certain fatigue-related crashes when fully phased-in. Although these options allow the same number of driving hours as option 2, they also require that long-haul (option 4) or long-haul and regional (option 5) drivers use an EOBR. This analysis implicitly assumes that use of an EOBR reduces fatigue-related crashes by an extra 15 percent. This extra safety is a result of increased driver's compliance with the HOS regulations.

We noted above that violation of the HOS regulations is widespread. Surveys of drivers have found that forty percent to three quarters of drivers violate the HOS regulations, depending on the definition of violation used. The precise level of violation is less significant that the fact that it appears to be ubiquitous. EOBRs make it easier for enforcement officers to determine if a driver is violating the HOS regulations. While EOBRs will not eliminate HOS violations, they will undoubtedly make violations more difficult to mask. A driver who drives over hours currently can falsify any one of a number of entries into the RODS to make it appear that he is in compliance. The EOBR will provide certain pieces of unalterable data, which will complicate the process of falsifying hours driving. An EOBR will make it easy for inspectors to determine when a driver began to drive. Depending on the option and the type of driver, the inspector will know that a driver working 12 or 14 hours after starting time is in violation.

By making it easier for inspectors to detect HOS violations, the EOBRs should have a deterrent effect and thus reduce the number and severity of violations. Increased compliance with the HOS regulations should lead to a reduction in crashes. We have assumed that drivers who use an EOBR will experience a 20 percent reduction in crashes, 15 percent more than the estimated reduction from the change in hours alone. Because of the uncertainty about the precise reduction brought on by options 4 and 5, we have included sensitivity analysis of different possible safety impacts in chapter 6.

Table 22 shows the FMCSA's baseline estimates of the number of fatalities deterred by the different options once they are fully phased-in. Table 23 shows the same estimates for injuries. Figures may not sum because of rounding.

Table 22
Estimated Reduction in Fatalities,
by Option and Driver Type

Option	Long-Haul	Regional	All Other	Total
Baseline	298	215	243	755
1	15	11	12	38
2	15	II	12	38
3	22	16	18	57
4	60	11	12	83
5	60	43	12	115

The following chapter, which analyzes the costs of these proposals, focuses on the cost of hiring new drivers to make up for reduced hours of some current drivers. There is some evidence that new drivers are less safe than experienced drivers. Jovanis et al find, for *one* national firm in the early *1980s*, that new drivers are 2/3 more likely to be involved in crashes than the most experienced cadre of drivers, those with over 10 years of experience. If the new drivers brought hired have a higher overall crash rate than the average current driver, this could somewhat offset the crash reductions estimated above. The reduction in fatigue related crashes could be counterbalanced by an increase in other crashes caused by new, less-experienced drivers.

The FMCSA does not believe that new drivers are likely to have a significant offsetting safety impact. First, it is unlikely that drivers who would have to reduce their hours under the proposal are especially safe. We believe that drivers who operate over the current limit are more likely to be involved in all types of crashes, not just fatigue-related. Thus, it does not make sense to compare the (possibly elevated) crash rates of new drivers with those of the average current driver; a more reasonable comparison would be with the rates of current below average drivers.

Second, it is not clear that new drivers would be as unsafe as those studied by Jovanis et al. Anecdotal evidence suggests that there are a large number of ex-truck drivers in other occupations. If the need for new drivers forces up driver wages (as discussed in the next chapter) some of these former drivers may return to driving. We have no evidence to suggest that these "non-new" new drivers are any less safe than current drivers. Indeed, to the extent that these returning drivers have alternate occupational options, they may be safer than current drivers. Ex-drivers in other occupations probably have a more desirable bundle of human capital characteristics than current drivers, which may be why they discontinued driving. This bundle of characteristics may be correlated with safety, further reducing any offsetting crashes by new drivers.

Ongoing research by UMTIP of JB Hunt, a very large national TL motor carrier, suggests that higher wages are correlated with both a lower monthly probability of turnover and a lower crash rate. Not only are higher wages related to drivers with more desirable overall characteristics, but any particular driver who receives a raise experiences lower turnover and crash rates. Accordingly, it is unlikely that there will be any increased crashes by new drivers.

Table 23
Estimated Reduction in Injuries,
by Option and Driver Type

Option	Long-Haul	Regional	All Other	Total
Baseline	7,785	5,613	6,307	19,705
1	389	281	315	985
2	389	281	315	985
3	584	421	473	1,478
4	1,557	281	315	2,153
5	1,557	1,123	315	2,995

Paperwork Reduction

Except for drivers who operate within a 100 air mile radius of their home base and who are relieved within 12 consecutive hours of the time they begin work, all drivers of CMVs in interstate commerce are presently covered by the record of duty status (RODS) requirement. The logbook contains a series of graph grid pages, and the driver must categorize each 15 minute increment as either driving, on-duty not driving, sleeper berth, or off-duty. Drivers must also record the location of all stops, deliveries, and pickups, and the location of any change of duty status (for example, from sleeper berth to driving). Drivers must keep their logbooks from the previous 7 or 8 days on their CMV. The RODS must also contain identifying information about both the vehicle and the specific shipment. The complete RODS requirements may be found at 49 CFR 395.8.

All drivers also need to prepare a time record for wage and hour purposes, pursuant to Department of Labor (DOL) regulations implementing the Fair Labor Standards Act. While the RODS and the time record overlap somewhat, the DOT and DOL use different definitions of work time. The DOL time record covers total work time, whereas the DOT RODS makes a distinction between driving work time and non-driving work time. Therefore, the FMCSA has not been able to use the time record for purposes of monitoring hours of service.

Because these options propose to eliminate the distinction between driving and non-driving work time, the FMCSA also proposes to remove the RODS requirement. Under options 1, 2, and 3, long haul and regional drivers would be required to prepare a modified DOL time card, which would include the time and location of any change of duty status (i.e., from on-duty to off-duty). These drivers would also be required to keep their time record on their vehicle when driving. Under option 4, long-haul drivers would require an EOBR, while both long-haul and regional drivers would require an EOBR under option 5. For all five options, all non-long-haul and regional drivers would be allowed to use the unmodified DOL time card, and would not have to keep the time card on their vehicles. The Agency would use the DOL time record to monitor compliance with the HOS regulations for specific drivers.

Options

In a paperwork collection request the FHWA previously submitted to the Office of Management and Budget (OMB), the Agency estimated that each driver spends 2 minutes a day completing a RODS, and that motor carriers spend 3 1 seconds per driver per day filing these records. Rounding down to 2.5 minutes per driver per day, and assuming that drivers work 5 days a week and 48 weeks per year, this amounts to 10 hours per driver per year. Many work drivers already are exempt from this requirement, under the 100 air-mile radius exemption. Some drivers defined as local, non-work in this NPRM are also able to take advantage of the 100 air mile radius exemption and forgo completing an RODS.

However, most local non-work drivers would have this burden eliminated. Some of the local non-work other drivers, as mentioned above, probably drive fewer than 100 air miles and return to their normal work reporting location and are relieved within 12 hours, and therefore are not currently required to till out an RODS. We assume that one fourth of the 3.997 million local, non-work drivers are currently eligible for the 100 air mile radius exemption, and the remaining 3 million local non-work drivers are not

Under all the options, most drivers will be able to use their time record in lieu of an RODS, and so save 2.5 minutes per day. Under options 1, 2, and 3, long-haul and regional drivers will also be able to discontinue using the RODS, but they will have to add onto their time record the location of any change of duty status (from work to off-duty, or the reverse). Option 4 would require long-haul drivers to use an EOBR, while regional drivers would be required to complete the RODS. Option 5 proposes that both regional and long-haul drivers use EOBRs. Option 4 requires long-haul drivers to use the RODS until their vehicle is equipped with an EOBR, and option 5 require both long-haul and regional drivers without an EOBR to till out the RODS. Table 24 shows the different options recordkeeping requirements for each driver type.

Table 24
Recordkeeping Requirements for Driver Types
by Options

	Long Haul	Regional	All Other
Options 1, 2, 3	Modified DOL	Modified DOL	DOL
Option 4	EOBR	RODS	DOL
Option 5	EOBR	EOBR	DOL

We estimate that the additional information required on the modified DOL time card, which is not currently required on time records, will take drivers 30 seconds a minute per day to complete. We also estimate that it would take half a minute per day to complete and file information generated by the EOBRs. Drivers using a modified DOL time card will therefore have one minute per day additional paperwork (half a minute for the additional information and another 30 seconds for tiling), and drivers with an EOBR will have 30 seconds per day of paperwork. Given the current baseline of 2.5 minutes per day, EOBR users will save 2 minutes per day, and modified DOL time card users 1.5 minutes daily.

Table 25 shows that drivers and clerks currently spend approximately 42.5 million hours completing and filing the RODS. Option 5 will eliminate 39.5 million of these hours, options 1, 2 and 3 will lessen the burden by 37.5 million hours, and option 4 will remove 33.2 million hours of paperwork. For options 4 and 5, the table shows the reduction occurring when the EOBR requirement is fully phased-in. The reduction is somewhat smaller in the initial years.

Table 25
Reduction in Paperwork Burden

Driver Type	Long Haul	Regional	Other	Total
Baseline	4,248,040	8,238,622	29,977,665	42,464,327
Reduction Option 1	2,548,824	4,943,178	29,977,665	37,469,672
Reduction Option 2	2,548,824	4,943,178	29,977,665	37,469,672
Reduction Option 3	2,548,824	4,943,178	29,977,665	37,469,672
Reduction Option 4	3,228,520	0	29,977,665	33,206,185
Reduction Option 5	3,228,520	6,261,352	29,977,665	39,467,537

With an estimated wage of $11.91 per hour from the Current Population Survey (described in more detail below), paperwork saving vary from $395 to $470 million per year when fully phased in. Paperwork savings for each option are listed in the middle column of table 26 below.

Total Benefits

Table 26 presents the Agency's estimates of the crash reductions of the five options, along with the estimated monetary benefits. Because options 1 and 2 will reduce crashes by the same amount, they will result in an equivalent level of benefits. The reduction in paperwork accounts for a approximately 70 percent of the total benefits of options 1 and 2, 60 percent of the benefit of option 3, and almost half the benefits of options 4 and 5.

Table 26
Annual Benefits of Proposals,
when Fully Phased-in

[redacted]	Fatal Crashes Avoided	Injury Crashes Avoided	Annual Crash Benefits, Mil	Annual Paperwork Benefits, Mil	Total Annual Benefits, Mil	10-year Discounted Bens, Bil
[redacted]	32	676	$183	$446	$629	$4.4
[redacted]tion 2	32	676	$183	$446	$629	$4.4
[redacted]tion 3	48	1,014	$274	$446	$720	$5.1
[redacted]tion 4	70	1,744	$400	$396	$795	$5.4
[redacted]	98	2,514	$558	$470	$1,028	$6.8

The benefits of this rule are recurring, as crashes are avoided, and paperwork reduced, every year the rule is in effect. Over a ten year analysis period, all options will yield substantial benefits, ranging from $4.4 to $6.8 billion. Figures in the rightmost column are discounted at a 7 percent rate.

Chapter 5
Costs

The options under consideration in this proposal would impose significant costs on motor carriers, ranging from $2.6 to $3.4 billion over ten years.

Some carriers would face administrative and organizational costs in shifting to any of the proposed options. Because of the difficulty in estimating these sorts of costs, and the Agency's belief that they would not be significant, we have not attempted to quantify administrative costs. The Agency prepared a qualitative discussion of some of these costs, which can be found after the quantitative analysis. This discussion also includes an examination of the impact of the some of the options on different industry segments.

Finally, we evaluated the costs of requiring drivers to begin work at approximately the same time every day. Imposing this kind of regularity on drivers was estimated to cost $2.2 billion annually. While there may be some commensurate safety benefit, the marginal safety benefit of regularity, on top of the other changes envisioned, is not likely to be large. Therefore, none of the options mandate regularity, although they all encourage it.

I) Background

We relied extensively on the UMTIP driver survey discussed above to estimate costs, particularly for option 3. Survey data were used to develop econometric equations relating driver pay to a number of independent variables, including nighttime and irregular driving. We then estimated the extra pay drivers would need to be compensated for reduced nighttime driving. Under some reasonable simplifying assumptions described below, this extra pay is assumed to equal the total social costs of option 3.

Similar calculations were performed to estimate the impact of regularity on drivers' pay, under the assumption that drivers would have to begin work at approximately the same time each working day. The driver pay equations were used to estimate the extra pay required to compensate irregular drivers whose schedules become regular. However, the regularity requirement was eliminated from the proposal, in part due its high net cost. The analysis of the cost of regularity is included at the end of this chapter.

In the absence of the regularity requirement, we estimated the reduction in the number of hours some current regional and long-haul drivers would work under the options, calculated the number of additional drivers required to drive those miles for options 1, 2, 4, and 5, and estimated the cost of hiring the additional drivers. For option 4 and 5, we also included the cost to purchase and maintain EOBRs, and to train drivers in their use. For option 3, we calculated the extra pay to drivers to compensate for lost wages when nighttime driving is reduced. The methodologies used are described below.

Nighttime Driving Methodology

The wage model constructed variables for the percent of nighttime driving and schedule irregularity based on information from the last complete trip cycle that each driver responding to the survey completed. These variables were used as proxies for the relevant measures over all of a driver's work. This implicitly assumes that the last trip cycle was representative of all the driver's work.

UMTIP estimated a recursive econometric equation system on a subset of the driver survey data. This equation, in which the reported wage rate is the dependent variable, provides a direct estimate of the marginal social costs of the proposals. Utilizing some simplifying assumptions spelled out below, we measure these costs directly, by using the estimated regression coefficients on the relevant proxy variables to simulate changes in the equilibrium pay rates of truck drivers due to reduced nighttime driving and reduction of schedule irregularity. These changes, in turn, were assumed to affect the cost structure of the providers of trucking services, the rates they charge, and the ultimate costs for those services that are passed on to consumers. Under some further simplifying assumptions, we use these estimates of the marginal social cost to compute estimates of the total social costs of the options. While the interpretation of the econometric results are theoretically well supported, given the assumptions, the estimated coefficients are statistically somewhat imprecise, especially for the limitation on nighttime driving.

For employee drivers paid by the mile, UMTIP estimated a wage equation designed to explain the nominal mileage rate received by each respondent in terms of a set of appropriate independent variables. The coefficients estimated for irregularity and nighttime driving show negative values; that is, other things equal, working irregular hours, or driving at night is associated with lower nominal mileage pay received. Under some assumptions stated below, this reduction in the wage rate can be interpreted as an estimate of the marginal per-mile benefit realized by society under the current level of these two operational characteristics.

The basic reasoning behind this interpretation is as follows. Drivers can be treated, to a first approximation, as if they only switch jobs based on how much they make in a week, once they are away from home. They work in a competitive labor market, if adjustments are made for union membership, and so their individual human capital characteristics essentially determine their next best job option, and hence the level of weekly wage they command. This is because, in competitive equilibrium, they can expect to make neither more nor less than the value to them of the hometime/weekly wage bundle that their fallback option would give them. So, a firm whose freight gives mileage-paid drivers more miles per week, either due to schedules that require a high proportion of night time driving, or due to schedule irregularity from "tour-of-duty acceleration," or due simply to excessive or intensified work, can on average pay a bit less per mile and still offer the weekly earnings level needed to just keep the marginal driver indifferent between working and quitting. But in a competitive freight market, this decrease will be reflected in freight rates, which are passed on ultimately to consumers. Hence, this decrease represents the marginal (i.e. per mile) social gain of such night driving or irregularity: The marginal cost contribution of truck transportation in the supply chain leading to consumer products is less by this amount.

This estimate is only for drivers paid by the mile, a limitation imposed by the problem of measuring nominal mileage rates for drivers paid by other methods (e.g. percentage of revenue). However, for a first approximation, we assume that the estimate obtained for mileage-paid road drivers is representative of that for all road drivers, and use this to approximate the total social cost involved in the policy change of setting “irregularity” to zero and limiting night driving.

This logic is theoretically correct - the nominal wage equation may be properly interpreted to give estimates of the marginal social benefit of present policies - if the following assumptions are true.

(1) Motor freight is an effectively competitive industry. Hence, the rates it charges approximately represent the marginal cost of providing trucking services.

This is relatively non-controversial, as a sizeable literature attests to the competitiveness of the motor carrier industry (Engel; Peoples).

(2) Road drivers are unconcerned about leisure consumed away from home, and therefore do not face a standard labor-leisure tradeoff. While away from home they tend to work as many hours as will increase their earnings, up to the limits defined by freight schedules and/or regulations. This is the most nontraditional assumption, but it is plausible for road drivers when away from home.

(3) The labor market for commercial truck drivers is approximately in long-term competitive equilibrium. That is, once we have accounted for differences in human capital and any other factors that explain differences in next best opportunities to the present job, drivers receive their reservation earnings and amenities bundle. So, once they go on the road, drivers bring home a weekly earnings package that makes them approximately indifferent between working on the schedule required on the road, and taking their next best job elsewhere.

The high turnover rate of drivers strongly suggests that this labor market is in equilibrium. Many motor carriers, particularly TL motor carriers, face turnover rates as high as 100% annually, which suggests that the marginal worker is indifferent between staying and leaving for the next best alternative.

(4) The level of night driving, and of irregularity in schedule caused by accelerating one’s tour of duty cycle to a more rapid pace than one driving shift every twenty-four hours are, to a first approximation, due to the demands of the market for freight services. That is, shipper loading schedules and delays, consignee delivery windows and queues, and the like, are primarily responsible for driver schedule irregularity and night driving (and hence the levels of these that we observe are predominantly exogenous, as opposed to being significantly due to endogenous driver choices).

None of these assumptions is literally completely true, but all four are defensible as approximate descriptions of the market for regional and long haul truckload (TL) motor freight services, and the associated labor markets for drivers. The less-then-truckload (LTL) segment, and probably local trucking services, differ primarily in that employees tend to receive significant employment premia (especially in LTL); the other three assumptions are relatively reasonable even in these parts of trucking When these four assumptions are approximately satisfied, then the following logic holds.

Freight that requires accelerated tour of duty schedules and night driving is associated with drivers running more miles (or having more hours of paid non-driving work, if applicable) per week, which increases weekly earnings. Thus, firms on average are able to pay drivers working this type of schedule less per mile, other things being equal, without lowering the drivers' weekly earnings. This in turn makes the firm's marginal cost of such movements lower. Since the market for freight services is competitive, this lower marginal cost results in lower rates on average to those who pay freight bills (shippers or consignees). These lower rates in turn flow through to consumers to the extent that links in the supply chain leading to consumer goods, in which such trucking services are a cost item, themselves operate competitively. The net result of cutting irregularity or night driving would thus be an increase in supply chain costs that would cause a leftward shift (reduction) in the aggregate supply function for consumer products.

New Driver Methodology

For the majority of drivers in compliance with the existing HOS regulations, the cost of most of the options would be minimal. These drivers would not face any significant reduction in the number of hours they could drive, either on a daily or a weekly basis. National truck load (TL) operations in compliance might have some difficulty complying with the weekly rest requirements. Less than truckload (LTL) motor carriers might eventually restructure their operations to optimize terminal locations, but this is not a cost of the proposal. LTL motor carriers would not suffer any declines in productivity if they failed to restructure, they would just forgo the opportunity to enhance efficiency.

Motor carriers with drivers who currently work more than 12 hours a day will face significant costs, regardless of whether they are in compliance with the existing rules. (As previously noted, drivers may currently work up to 15 consecutive hours, and they may drive 2 ten hour stretches separated by eight hours off duty. Some drivers who drive more than 12 hours a day are probably in compliance with the FMCSRs, while others likely are not). These drivers will have to reduce their driving hours, and motor carriers will have to make up for these "missing" hours. We assume that motor carriers will hire additional drivers to make up for the missing drivers. The reduction in hours will result in a commensurate reduction in pay for drivers who work more than 12 hours, which will significantly lower motor carrier costs.

The need to lure additional drivers will have the opposite effect, raising wages for both current and new drivers Given the tight labor market, motor carriers may have to increase the baseline wage to induce workers in other fields to become truck drivers. Current drivers who work 12 or fewer hours will get this pay raise, as will new drivers. The magnitude of the wage increase required to lure new workers depends on the number of new drivers needed and the elasticity of labor supply. We estimate that motor carriers will need approximately 50 thousand new drivers, approximately 4 percent of the number of long-haul and regional drivers. We also use a wage elasticity of 10, which means that to increase the number of drivers by 4 percent, wages will have to rise by .4 percent.

The wage elasticity defines the relationship between the percent change in wages and labor. An elasticity of 1 ("unit elasticity") indicates that to increase labor by a given percent, wages would have to rise by exactly that percent. For example, to increase the number of drivers by 30 percent, wages would need to rise by 30 percent. With an elasticity of 2, wages would only need to rise by 15 percent to yield a 30 percent increase in drivers.

Ideally, the analysis should use the wage elasticity for potential truck drivers, but no detailed information of this sort exists for the cohort of individuals who might become truck drivers. UMTIP's supporting economic analysis used values of 1 and infinity to put boundaries on the likely range of elasticities. An infinite elasticity represents a perfectly elastic labor supply, as it implies that motor carriers do not need to raise their wages at all to attract new drivers. An elasticity of 1 implies an percent increase in wages commensurate with the increase in drivers.

While there is no data on potential new drivers, two considerations suggest that the responsiveness of labor supply to wages is relatively elastic. First, barriers to entry are very low. Second, historical data show that employment growth in the industry has not been significantly impeded by wage movements. Accordingly, Hirsch and Macpherson describe the driver labor supply as "highly elastic" (Hirsch and Macpherson). Although we use an elasticity of 10, we conduct some sensitivity analysis of the elasticities of 1 and infinity.

For options 4 and 5, we estimated the cost to purchase EOBRS, train drivers in their use, and maintain the systems.

Quantitative Cost Estimates

Options 1 and 2

Tables 6 and 7 show that at both the mean and median, long haul truckload drivers work about 11 hours per day, 8.5 of which are driving. [1] These drivers would be in compliance under these options, as they are with the existing regulations. At the 60^{th} percentile, long haul drivers work 12 hours per day, which indicates that 40 percent of long haul drivers work more than 12 hours, and would have to reduce their

---

[1]As discussed previously, some of the driving characteristics reported in the UMTIP driver survey may be biased upwards, since drivers who use truck stops probably operate more miles than those who do not use truck stops. To reduce the impact of this "long-haul" bias, we assume that drivers categorized as both long-haul and regional in the survey are actually long-haul according to the definitions of this NPRM. Accordingly, in the following pages, numbers for long haul drivers are averages of the figures for long haul and regional drivers from the UMTIP driver survey.

daily working (and possibly driving) time under these options. At the 80th percentile, long haul truck load drivers work 14.5 hours and drive 11 hours. These drivers *may* be in compliance with existing regulations if their driving time is not consecutive, but they would clearly be out of compliance with the NPRM, as they would exceed the maximum allowable number of hours working.

We estimate that at the 80th percentile, regional truck load drivers drive 13 hours, 1.5 hours fewer than there long haul counterparts. This adjustment accounts for the shorter trip lengths of these drivers.

LTL drivers operate quite differently than TL drivers. Instead of the highly variable long distance trips common among TL drivers (particularly owner-operators), LTL drivers tend to drive the same routes, often working at the same time of day. The UMTIP survey likely undersampled LTL drivers, as they are less likely to stop as rest areas than are TL drivers. Anecdotal evidence also suggests that LTL drivers are unlikely to violate the HOS regulations. LTL carriers are likely to have less incentive to violate the HOS regulations than TL carriers, as there operations are optimized for the current regulations. For a typical cross country TL run, driving 10 percent more hours than allowed under the regulations would reduce overall trip time be approximately 10 percent. A typical over-the-road LTL trip would consist of 5 hours from one terminal to another, then another 5 hours back. For these types of trips, there is less incentive to drive more than 10 hours, as there is nothing for the driver to do with the extra time.

According to the 1997 Vehicle Inventory and Use Survey (VIUS), the successor to the TIUS, 31.4 percent of large trucks are used in LTL operations. We estimate that 80th percentile LTL drivers drive 12.5 hours per day, rather than the 14.5 hours of national TL drivers.

Approximately forty percent of long haul drivers, those between the 60th and 100th percentile working time, would have to reduce their working hours under the NPRM. Drivers at the 61st percentile would only need a modest reduction in working time to come into compliance, while those at the 99th percentile would require a substantial reduction in hours. We estimated the cost of bringing the midpoint over-hours driver, at the 80th percentile, into compliance with the NPRM.

We calculated the number of hours motor carriers would "lose" if all over-hours drivers drove 12 hours per day. Carriers would need to make up approximately 586 thousand missing hours, which translates into almost 49 thousand drivers (586,185 lost hours per day / 12 hours per driver = 48,849 drivers).

Table 27 shows the number of drivers, hours at the 80th percentile, and assumed percentage of total drivers, and the number of drivers needed to make up for lost hours, for the different driver types used for the cost analysis.

Table 27
Driver Characteristics by Driver Type

	% Drivers, by Distance	Number	Hours worked, 80th Percentile	New Drivers Needed
Long Haul LTL	31%	133,320	12.5	1,944
Long Haul TL	69%	291,484	14.5	24,290
Regional LTL	31%	258,560	12.5	3,771
Regional TL	69%	565,303	13	18,843

Motor carriers would need to hire a total of 48,849 new drivers, the vast majority of them in the truckload sector. This equals 3.9 percent of the current number of regional and long haul drivers, so with an elasticity of. 1, drivers wages will have to increase by .39 percent to induce 48.8 thousand individuals to become truck drivers.

As discussed above, the cost to motor carriers would be determined by 3 interacting forces: a reduction in wages to drivers who currently drive more than 12 hours per day, an increase in wages for current drivers as a result of the need for higher wages to attract additional drivers, and the wages for new drivers. Regression analysis of 1997 data from the March 1998 Current Population Survey shows that the average 60 hours a week truck driver makes $35,737, while the average 70 hours a week driver makes $38,959 annually. Just under 480 thousand long haul drivers currently drive more than 12 hours, and would have their wages lowered under the options considered in this NPRM.. Motor carriers would save $1.55 billion in wages for these drivers (479,843 drivers x ($38,959-35,737)).

The new equilibrium 60 hours per week wage would be $35,877 ($35,737 wage* .39 new drivers* .1 elasticity). This is $139.81 greater than the previous 60 hour a week wage, and all 1,248,667 long haul and regional drivers would get this raise. This would cost motor carriers approximately $175 million per year (1,248,667 drivers x $139.81 = $174.57 million).

The largest cost for motor carriers will be hiring new drivers. At an average wage of $35,877, the 48,849 new drivers needed will cost motor carriers $1.75 billion per year ($35,877 new wage x 48,849 new drivers). The net effect of these three changes will be an increase in drivers costs of $384 million per year ($1.755 billion for new drivers + $174.57 million for existing drivers - $1.545 billion for over-60-hour drivers).

Motor carriers could also attempt to make up for lost hours by increasing the number of hours current drivers work. Table 6 indicates that many drivers drive significantly less than 12 hours per day, and it is possible that some of these drivers may be able to assume some of the lost hours previously worked by their colleagues. While this may be possible for some LTL operations, it seems unlikely to be feasible for TL motor carriers. A driver who runs out of hours distant from the home terminal in most cases can not be efficiently replaced with a new driver. While it is possible to imagine some circumstances where hours could be shifted to drivers who work less than 12 hours, it is unlikely that many hours could be replaced this way.

Finally, motor carriers could make up for lost drivers hours by increasing the efficiency of existing drivers. About one quarter of long haul drivers' time consists of non-driving work, much of which generates little value to carriers (or the economy). A moderate reduction in this proportion of non-driving work would allow for more hours of driving, which could offset the reduced hours of other long haul drivers. A smaller but still significant percent of drivers time is spent waiting, which is entirely unproductive.

Motor carriers do not entirely control how many hours drivers wait or are engaged in non-driving work, and therefore would have difficulty dramatically reducing this percentage on their own. Drivers schedules are dependant on the conditions and demands of shippers and receivers, so any concerted effort to reduce non-driving time would need their cooperation. It is not clear what incentive shippers, receivers and others would have to cooperate, as wasted drivers time is largely costless to them. Motor carriers could presumably squeeze some inefficiency out of the delivery system, but it is unlikely they could achieve a significant reduction in the amount of non-driving work time or waiting without widespread cooperation from their customers.

Option 3

The driver survey shows that drivers are paid less for nighttime than daytime driving. Therefore, drivers who lose nighttime hours will have to be paid more for their remaining driving time to reach their earnings target. The extra drivers wages, which will be passed through in higher costs, constitute the cost of this option. We estimate that this option increases costs by approximately $375 million annually. This section explains how this estimate was derived.

Drivers paid by the mile reported working an average of 66.3 hours in the week prior to the survey, with 75.3% of those hours driving, for an estimated 49.9 weekly driving hours at the mean (66.3 x 0 .753 = 49.9). Option 3 would limit drivers to 18 hours of driving between midnight and 6 AM per week, 18 hours represents 36% of mean driving hours (18/49.9 ≈ 0.36). However, the UMTIP survey asked drivers about driving between 1 I PM and 7 AM, whereas this option limits driving between midnight and 6 AM. If we assume a uniform distribution of driving over the eight hours, then hours between midnight and 6 AM should be 75% of those for the longer period. 36 percent of nighttime driving for the longer period translates into 13.5 hours for the shorter period (18 x 0.75 = 13.5). To accumulate 18 hours of driving between midnight and 6 AM, 48% of drivers' time must fall between 11 PM and 7 AM (1/.75 x .36 = 0.48). This is approximately equal to the percentage of night driving at the seventy fifth percentile of the survey distribution, which suggests that about one quarter of all drivers would be affected by an eighteen hour limitation.

To calculate the marginal effect of this limitation, we computed the increase in wages required to shift someone at the ninetieth percentile of the percent night driving distribution down to the seventy fifth percentile. To estimate the total social cost we scaled this figure up by applying this change to one quarter of the long-haul and regional drivers and one eighth of local and work truck drivers. The ninetieth percentile night driver has 66.7% of his driving at night, and to cut this level to the 46.7% of the seventy-fifth percentile night driver is a drop of 30%. The point estimate of the effect of the percent of night driving on the wage is -.0415. (This is based on the wage equation discussed previously. A complete explanation of the equation can be found in the docket). This estimate is statistically significant at the 93.75% level. This estimated value can be interpreted as the elasticity of the wage with respect to the percent of night driving at the mean of the wage. At the mean wages but the ninetieth percentile of the night driving distribution, the elasticity equals .091% (-.0415 x (.667/.303) = .091%). Hence, a 30% drop in the percent night driving should be associated with approximately a 2.74% increase in the wage (30 x .091% = 2.74%) or .027 x $.303 = $.0083 per mile. This figure represents the extra per-mile wages drivers would have to be paid to compensate for their lost income from reduced nighttime driving.

Drivers classified as local in the UMTIP survey reported somewhat less nighttime driving than drivers classified as long-haul and regional. As discussed above, by surveying drivers at truck stops, the UMTIP driver survey probably does not capture a representative sample of local drivers, as defined in the FMCSA's proposals. Most local drivers probably do not stop at truck stops, and those who do are likely to be systematically different from drivers who do not visit truck stops. Accordingly, we assumed that local and work truck drivers are only half as likely as long-haul and regional drivers to drive more than 18 nighttime hours per week. UMTIP estimated that 25% of long-haul and regional drivers (those between the 75th and 100th percentile) would have to reduce their nighttime driving; the FMCSA reduced this figure to 12.5 percent for local and work truck drivers.

We then multiplied the $.0083 per mile by the average annual miles for each operational type. As discussed above, the definition of drivers from the survey probably does not match those envisioned in this proposal. We assumed that those labeled long haul and regional in the survey are long haul according to the NPRM's definition, and drivers who call themselves local in the survey are closer to regional drivers in the NPRM. Work truck drivers were effectively outside the scope of the survey. Accordingly, we estimate that long haul drivers drive 114 thousand miles annually, the average for long haul and regional drivers from Table 4, and regional drivers drive 82 thousand miles, the figure reported for local drivers We assume that both work drivers and local non-work drivers operate 25 thousand miles per year.

The average number of miles was multiplied by the 25 percent of long-haul and regional drivers, and 12.5 percent of local and work truck drivers, who drive more than 18 nighttime hours per week. The calculations for the total cost is as follows: $.0083 per mile multiplied by the number of miles per year, times the percent of drivers who drive more than 18 hours per week. The total cost is approximately $375.3 million per year. This represents an annual cost, as carriers will continue to pay drivers extra to compensate for missing earnings. At 7 percent discount rate, the ten year cost of compensating drivers for reduced nighttime driving is $2.64 billion.

Table 28
Annual Cost of Option 3

	# Drivers	Avg Miles	Cost per driver	Total Cost, millions
Long-Haul	424,804	114,000	$946	$100.5
Regional	823,863	82,065	$681	$140.3
Local, non-work	3,997,023	25,000	$208	$103.7
Work	1,190,740	25,000	$208	$30.9
Total	6,436,430			$375.3

Option 4

Option 4 is similar to option 2, except that all long haul vehicles must be equipped with an electronic on-board recorder. This requirement raises the cost (and, as explained in the preceding chapter, the benefit) of this option considerably.

The FMCSA estimated above that 5 percent of long-haul motor carriers currently use EOBRs. Based on TIUS data, we also estimated that there are almost 266,102 long-haul CMV power-units, and 242,069 regional trucks. Assuming that carriers which use EOBRs are the same size as those without the devices, 5 percent of long-haul trucks are now equipped with an EOBR. Therefore, carriers will have to purchase 252,798 EOBRs (0.95 x 266,103).

Queries of manufacturers, surveys of users and manufacturers of EOBRS, and comments to the ANPRM docket reveal a wide range of estimated costs for EOBRs. A 1997 motor carrier survey undertaken for the FHWA reported an average cost of $2,000 per EOBR (Cambell). In comments to the ANPRM docket, the Insurance Institute for Highway Safety (IIHS) cited a telephone survey of onboard computer manufacturers. The cost for the first truck ranged from $1,089 to $19,000. Most of the manufacturers cited a high and low cost: the mean low cost was $4,500, while the mean high cost was approximately $9,000. For additional trucks, prices ranged from $585 to $4,000, with a low cost mean of $1,150 and a high mean cost mean of $2,200. IIHS prices are presumably in 1994 dollars. Other commentors offered estimates of between $700 (Rockwell Transportation Electronics) and $5,000 per vehicle (Rocor Transportation).

The FMCSA also contacted two manufacturers of EOBRs, who quoted prices of $2,000 and $2,400. These manufacturers also cited other costs, such as software, driver cards, card readers, and training. One manufacturer quoted a price of $10,000 for software, while the other charges $5,200 for software and approximately $6,000 for a high-end dedicated computer. These items could easily double the per unit cost, depending on the specific configuration and assumptions about the number of drivers per carrier and terminal. However, it appears that these prices are for high-end models, which have many capabilities in addition to the ability to record HOS. These extra capabilities include such items as speed governors, recording various engine and mechanical data, and global positioning system tie-ins. Options 4 and 5 would require carriers to use an EOBR for HOS compliance only. The FMCSA believes that several low-end EOBR systems exist. The NPRM contains a discussion of some of the systems which would meet the requirements of this option. Therefore, the costs for the extra capabilities should not be included as a cost of these options. The Agency does not have a reliable estimate of the cost of an EOBR capable of recording a drivers HOS only.

This analysis uses a purchase price of $1,000, with annual costs of $100 per unit. The $100 annual figure covers a number of costs that we were not able to directly estimate, including maintenance costs, search costs, transaction costs, and learning curve costs. The FMCSA also assumed that drivers of vehicles with EOBRs would need 2 hours of training, at $11.91 per hour (from the Current Population Survey). Because of the wide range of estimates, we analyzed the impact of higher and lower EOBR prices.

Over ten years, long-haul motor carriers would pay $253 million for the purchase of EOBRs, $229 million for maintenance, and $9.6 million for training, for a total undiscounted cost of approximately $492 million. Purchase and driver training costs are concentrated in the early years, while maintenance costs are evenly spread over ten years At a seven percent discount rate, this translates into approximately $387 million.

This option has the same driving limitations as option 2, and therefore the analysis carried out above is applicable for this option. On top of the EOBR costs, motor carriers would have to pay an additional $384 million annually in driver wages, $2.696 billion discounted. The net present value of all costs for this option is $3.024 billion.

Option 5

Option 5 is the same as option 4, except both long-haul and regional drivers would be required to use an EOBR. Minimum off-duty hours, maximum driving time, and "weekend" rest provisions are unchanged.

As discussed above, we calculated that there are 508,171 long-haul and regional trucks. Five percent of trucks are already equipped with EOBRs, so the remaining 482,766 vehicles would have to be equipped with them .95 x 508,171).

Using the figures developed above, the ten years cost of purchasing EOBRs is $483 million, maintaining the devices would cost $438 million, and training would add another $28.3 million, for an ten-year undiscounted cost of $949. The discounted EOBR cost is $748 million, with costs fairly evenly split between long haul and regional motor carriers. Small carriers will pay 35 percent of the EOBR costs, large carriers 54 percent, and medium carriers the remaining I 1 percent.

This option has the same driving limitations as option 2, and therefore the analysis carried out above is applicable for this option. In addition to the EOBR costs, motor carriers would have to pay an extra $384 million annually in driver wages, which equals $2.696 billion discounted over ten years. The net present value of all costs for this option is $3.444 billion.

Small Business Costs

Approximately half a million motor carriers were listed on the MCMIS census file in the fall of 1999, and the FMCSA has data on the number of vehicles owned by 413 thousand of them. Almost half of the motor carriers with size data have only one truck, and 95 percent of motor carriers, almost 395,000, have 20 or fewer trucks. These small motor carriers owned approximately 37 percent of the registered trucks. The average small motor carrier operated just under 3 trucks.

Small long-haul and regional carriers would face significant costs from this proposal, particularly options 4 and 5. These motor carriers would bear 37 percent of the higher wages and EOBRs. We estimated above that driver wages would rise by $384 million per year. Small carriers would bear 37 percent of that cost, approximately $142 million annually, which equals $361 per small motor carrier. Small motor carriers with larger fleets will pay more than their smaller counterparts.

Under option 4, small long-haul motor carriers would face an extra $177 million over ten years for EOBRs ($135 million discounted). Purchasing the EOBR constitutes approximately $100 million of this cost, and it is split evenly between the first four years Ongoing maintenance accounts for the bulk of the remaining costs, and it is spread out over ten years. EOBRs will cost the average small long-haul motor carrier $2,850 to purchase and $282 annually for maintenance (undiscounted).

Option 5 would cost small long-haul and regional motor carriers $180 million undiscounted to purchase EOBRs, $152 million discounted. Annual costs equal $17.9 million undiscounted, for a total of approximately $103 million discounted over ten years. Per carrier costs are the same as for option 4, because of the method used for calculating costs.

Data on firms and receipts from the Small Business Administrations (SBA) web site were used to generate an estimate of average receipts for small motor carriers. The FMCSA used data from Standard Industrial Classification (SIC) codes for trucking, SIC codes 4200 through 4214. Small motor carriers, defined as those with fewer than 20 employees, had average annual receipts of just over $400,000 in

1996. First year costs of $3,132 ($2,850+$282) equal approximately three fourths of **one** percent of the average small motor carriers receipts.

The previous calculations include only motor carriers in SIC codes 4200 through 4214, which include motor freight transportation and warehousing, trucking and courier services, local trucking without storage, non-local trucking, and local trucking with storage. Many small establishments covered by this NPRM are in other industrial sectors, and therefore would not be included in this estimate. There are a large number of private carriers, those which do not accept for-hire shipments, but instead serve as a shipping subsidiary of an establishment in a different line of business. Examples include bakeries or groceries which own small fleets of trucks to deliver their goods, or a touring musician who travels via a privately owned motor coach. The FMCSA was not able to generate data on these private motor carriers.

It is likely that both EOBR and driver costs could be lower than estimated above. First, we assumed that small motor carriers would purchase one quarter of their EOBRs in each of the first four years. In reality, it is likely that most small motor carriers will wait until the latter years to buy an EOBR. This will lower the discounted EOBR costs, as later year purchases are discounted more highly than earlier ones. In addition, small motor carriers who purchase EOBRs in year 4 will have to pay for maintenance for 3 fewer years than those who purchase in the first year.

Second, the FMCSA believes it is likely that the price of EOBRs will fall as production increases. As manufacturers gain proficiency in producing a good, improved use of labor and materials tend to lower the costs of production. Improvements include reducing the number and complexity of component parts, improved production of components, improved assembly speed and processes, reduced error rates, and better manufacturing processes. In a 1984 study of 108 manufacturing items from 22 field studies, Dutton and Thomas found a progress ratio of slightly higher than 80 percent, which means that each doubling of cumulative production reduces the cost level by 20 percent (Dutton and Thomas). Because of the phase-in period for small motor carriers, larger motor carriers are likely to bear the higher initial production costs.

In addition, wage costs may also be lower than estimated. Small motor carriers, like many small businesses, tend to pay lower wages than their larger competitors (Brown and Medoff for overall wage differential; Hirsch and Macpherson for motor carriers). Therefore, a given percent increase in wages will translate into a smaller absolute change than is the case for higher wage firms. The overall percentage figure used in this analysis may overstate the wage increases faced by small motor carriers.

As noted above, the FMCSA assumed that EOBRs will cost motor carriers $100 per year. This figure includes such items as maintenance, search costs, other transaction costs, and learning curve costs. While we were not able to directly estimate the separate cost components, we do not believe they will be significant. Manufacturers and salespeople for EOBRs will have a substantial incentive to provide information about their products to drivers. Unions, magazines, and trade associations are also likely sources of information for drivers. The costs to reach the long-haul and regional drivers who will be required to purchase EOBRs are fairly low, as these drivers often congregate at rest areas and loading docks, and many drivers communicate with other drivers via CB radio. The relatively high concentration of drivers lowers the cost of reaching drivers, provides further incentives for manufacturers, salespeople, and other to provide information on EOBRs to drivers.

The analysis also assumes that many motor carriers will be able to have EOBRs installed during routine annual checkups. Motor carriers are required by the FMCSRs to inspect their trucks annually, and many carriers routinely inspect their vehicles more frequently. The FMCSA believes that many motor carriers may be able to have an EOBR installed while their trucks are undergoing routine maintenance, lowering the opportunity cost of obtaining an EOBR. For most motor carriers, the opportunity cost of an EOBR is only the additional time required for installation once a truck is already available for service.

Qualitative Costs

We can expect different effects from different aspects of the proposed changes. The following section discusses the likely impact of options 1 and 3 on the industry. We did not prepare a discussion of options 2, 4, or 5.

Option 1

Daily scheduling.

The regional LTL industry would have the least difficulty conforming with this schedule, as most freight follows the overnight rhythm The ability to use the driver for 12 hours regardless of activity (driving or other labor) would give the motor carriers more flexibility. We are not sure how much of this additional capability them might use but it allows them to adjust according to the demands on their business. The national LTL industry would also be able to adjust to this option as they now use their drivers for less than 10 hours of driving at a time (and at least the union carriers do not require drivers to do other work) and would have the additional flexibility to use drivers beyond 10 hours if necessary

One difficulty both industry segments may face would be a possible reduction in overall labor time: option 1 specifies that the 12 hours includes all breaks, so the net effect might be to reduce total daily labor by as much as 10 percent or as little as zero. Assuming drivers work 11 hours per day for five days per week, that gives them a 55 hour work week, which is about what we would expect in the industry

The long-haul TL industry, at the other extreme, would have to make major changes to adjust to this schedule. Many TL drivers currently work more hours than this rule would allow. If other reforms reduced drivers non-productive time, as discussed above, the effect might be minimized. That is, since the median long-haul driver drives only 8.5 hours daily, this might not affect the driving experience of drivers at the median. However, at the 75th percentile long-haul drivers drive 11 hours, suggesting that the only way many drivers could comply would be by eliminating non-driving hours entirely. In sum, the long-haul TL industry probably would have to hire more drivers than it currently has, assuming drivers and motor carriers actually complied with the regulation and assuming no change in the current framework that does not discourage shippers and consignees (and even carriers) from wasting drivers' time.

Regional trucking generally operated in a fashion closer to LTL than to the long haul trucking industry. Although data are sketchy, the UMTIP Driver Survey suggests regional trucking falls approximately in the middle between local and long haul, depending on the measure. Regional drivers are more likely on average to perform labor other than driving than the long-haul TL drivers, though the latter have larger blocks of non-productive time. It is difficult to generalize among such a wide set of possibilities, in terms of industry segments and markets, so conclusions are difficult to make based on the proposed regulation and the current work schedule. Work schedules vary quite widely due to industry segment.

Weekly scheduling

Proposed regulations would require at least two nights for sleep at the end of a work week. The regional LTL industry already is structured in this way, at least as closely as any other group. The typical regional LTL driver begins his work week Monday evening or night and works 5 "shifts" of driving and labor and ends up back at his home domicile by Saturday morning (some motor carriers might add an additional shift to meet their service requirements). While the proposed regulations would limit the flexibility of these firms with respect to extra driving (because of the requirement of a minimum of 58 consecutive hours off once per week), they would have the least effect on these drivers.

The long-haul LTL industry is not scheduled in this way. While these LTL carriers could adapt to this schedule, they could do so only with some effort and dislocation. Their operations currently depend on a mix of regular bid runs, on-call drivers, and casual drivers. City drivers (pickup and delivery) have reasonably regular shifts, ordinarily are paid by the hour, and probably stick pretty closely to the recommended HOS limits and schedule. Regular bid road drivers run steady operations between cities and haul the most predictable freight. As a result, their schedules are predictable and can most likely conform to the daily and weekly HOS rules. Lower-seniority irregular road drivers who maintain a low position on a seniority list are called in to work as the carrier is able to "close out" a trailer and send it to another destination. Such destinations vary, but sharp cutoff times needed for regional LTL aren't needed in national LTL and hence the daily discipline is not as critical. Bigger terminals generally have a higher number of bid drivers, and may be able to create relatively restricted time windows during which daily dispatch can occur. Weekly regularity is a bigger problem, since that is not a current requirement. We have no way to estimate the cost of compliance for this industry.

Both the regional and national LTL industries may find it difficult to adapt structurally to different options regarding hours of service. Currently these carriers take both business and regulatory constraints into consideration when planning terminal networks. That is, they consider the metropolitan area in which they may pick up and deliver freight (or where they have appropriate freight density) along with the distances between terminals between which they transfer freight throughout their network. Any changes in daily hours of service regulations could induce them to move terminals closer together or farther apart. We believe that some readjustment would undoubtedly take place, but, as we discussed above, this should not be considered a cost of this proposal. Motor carriers who do not relocate terminals will not face any additional costs because of this option, they will merely be bypassing an opportunity to realize savings.

The regional trucking industry (particularly TL and other-than-general-freight) probably could adapt to this change relatively easily also, since they are better able to get drivers home on weekends or on a weekly basis. Currently these carriers advertise "home weekends" as a recruiting tool, so undoubtedly their workers and potential workers view this as a benefit. While they scarcely comply with the current weekly limit (the UMTIP Driver Survey shows them working 60 hours per week at the median), their biggest problem probably will come more in adapting to the 60 hour limit than in adapting to the schedule providing for 58 hours of continuous off duty time weekly.

As was the case with the daily restrictions, the long-haul TL industry would find it the most difficult to adapt to the weekly limitations. Currently drivers are working through this period and view lengthy delays on the road as tiring time wasters. Since these drivers typically sleep in their trucks and may have to spend this time in truck stops when their weekly break occurs on the road, they might not achieve the level of rest anticipated by the rule even if they obey the regulation. For analytic purposes, however, it might make sense to divide the long-haul TL industry into two broad segments.

Smaller TL motor carriers run their drivers long distances and generally have their drivers spending weeks on the road. While we have not analyzed this phenomenon in detail, research suggests the smaller carriers have fewer alternatives to this form of operation. That is, if they dispatch a driver on a long cross-country run they alone are responsible for locating freight for the return trip. We suspect their inability to locate freight on a timely basis contributes to the "wasted time" phenomenon observed from the survey. Larger motor carriers may be more likely to locate freight for the return at a distance, though every carrier faces challenges maintaining freight balance over long routes and between fat-flung city pairs.

Perhaps the biggest advantage larger motor carriers (or more precisely, motor carriers with denser regional concentrations and freight lanes) have over smaller ones is some ability to relay freight from one region to another. The ability to relay freight from one driver to another would allow the motor carrier to keep drivers within a reasonable proximity of home and allow them greater opportunities to return them home for the 58 hour breaks. Without this option, long-haul carriers and their drivers would find it rather difficult to adapt to this regulation. One unintended consequences might be a continuation of the current situation, whereby drivers extend their overall hours of service by logging non-productive time as off duty, so that they can maximize driving time, which is paid.

Option 3

This option has two primary components. The hours-of-service requirements are the same as the previous options. The impact of these aspects of the regulation on the industry has been analyzed above and will not be repeated here. The second dimension is the limitation on night-time driving. The following analysis assesses this impact.

The proposed limitation on night-time driving could cause major restructuring in the LTL industry. Most LTL carriers, especially in the regional industry, run throughout the night. The regional LTL industry relies on night-time driving. Its primary niche is the overnight service lane, and the structure of operations requires night time driving. To summarize and simplify their operations, they pick up freight during the afternoon and bring it to a terminal where it is stripped off local trailers and reloaded on road trailers for delivery The dock operation may take anywhere from 3 to 5 hours, after which the loaded trailers are dispatched over-the-road to a terminal or terminals in another city. The freight may be handled once or twice en route during the night. In any case, the freight arrives at its destination terminal the following morning, is stripped off the road trailer and loaded onto a city trailer. A city driver ("pickup and delivery driver") takes the freight to the customer, and repeats the pickup process. This pattern ordinarily continues Monday through Friday, with most freight picked up and delivered on those days.

Variations on this theme apply to the inter-regional LTL carriers as well as to national package delivery carriers, much of whose revenue actually consists of regional and local freight. National LTL carriers (along with inter-regional LTL carriers and package carriers) have wider variation in operations. The pickup and delivery processes are the same, but longer lanes mean that the intermediate dispatch can take place around the clock. Some motor carriers are structured such that inter-regional movement of freight will tend to happen on the same night-time lanes on which their overnight shipments travel, and some motor carriers are structured so that second- and third-day freight will travel during the day for at least some of its intermediate movement. In any case, the entire industry depends on night-time freight movement, and limiting drivers to 18 night-time hours per week could cause major restructuring. Indeed, since this restriction likely would restrict drivers to three days of work per week (less than full time), carriers might adapt by switching their drivers between night-time and day-time shifts throughout the week. While this would comply with the regulations, it could disrupt drivers' circadian cycles, eliminate the possibility of regular schedules, and possibly reduce overall safety

The UMTIP Driver Survey suggests the extent of night-time driving is somewhat lower than previously thought. The driver survey reveals that, on average, drivers already are well in compliance with such a proposed rule. The discrepancy comes at the extremes. People who are on the night shift perform all of their work during these hours, so as individuals they would be far from compliant with a proposed 18 hour limit. This group includes those who drive for most regional LTL carriers, for package carriers, and probably for much of the inter-regional and national LTL industry Those who drive for TL firms (particularly long-haul) may well drive a small enough percentage of their hours during this period that they would be in compliance. However, the drivers most likely to be compliant with the 60 hour limit probably are the very drivers whose industry would be altered dramatically as a result of such a regulation. Finally, while data are sketchy some analysts believe the LTL and package industry have a lower than average crash rate, so this option affects the operations of those carriers that contribute least to the nation's highway safety problem.

Regularity

The FMCSA also examined the cost of requiring drivers to begin work at the same time each day. The specific proposal under consideration would prevent drivers from working until 23 hours after the previous day's start time. A driver who started work at 6 AM Monday morning would not have been allowed to begin again until 5 AM Tuesday, regardless of how many hours he had driven or worked on Monday.

We used the wage equation described above to estimate the cost of regularity. The coefficient on the proxy constructed for irregularity (a binary variable) is -0.0196. It is statistically significant at the 14.5% level, which means it is estimated relatively imprecisely, lowering confidence in the estimate's numerical value. Under the assumptions outlined above, in equilibrium we expect that the typical irregular driver gets on average more miles (or more paid hours, where applicable), and so makes about the same annual income as a regular driver, other things equal. If we prohibit irregularity, then these drivers will have to be paid almost 2 cents per mile more on the smaller number of miles they will then run to make the same annual wages.

Using the average annual miles from above, (hence not trying to explicitly capture any implied change in miles), carriers would have to pay between $500 and $2,200 per year in higher per mile wages over fewer miles for the average irregular driver in order to restore his wages to their approximate pre-regulatory change level. Hence society will pay that much more in higher freight rates for the freight each irregular driver now hauls, if irregularity were prohibited and all drivers complied with the prohibition.

We treat all drivers (including owner-operators) like the average mileage-paid driver, and assume that 23.4% of this entire population is "irregular", the percentage found in the driver survey. This results in total costs of over almost $1.5 billion per year, as shown in Table 29. Regional drivers account for more than 55% of the total cost of mandating regularity.

Table 29
Cost of Regularity

	# Drivers	Average Miles	Cost per Driver	Total Cost, Millions
Long-Haul	424,804	114,000	$2,234	$207
Regional	823,863	82,065	$1,608	$837
Local Non-work	3,997,023	25,000	$490	$69
Work	1,190,740	25,000	$490	$369
Total	6,436,430			$1,482

Because of the substantial cost, the FMCSA is not proposing to mandate regularity in the NPRM. The FMCSA recommends that carriers and drivers keep regular schedules to the maximum extent possible.

Chapter 6

Costs and Benefits

All options yield net benefits, with the benefits generally increasing with the option number. When paperwork benefits are excluded, only option 5 has net benefits, while the remaining options yield net costs.

Table 30 reprints the estimated fatal and injury crashes avoided from table 25, and presents estimates of the number of fatalities and injuries avoided. The rightmost column calculates the monetary value of these avoided incidents, based on a value of $3.388 million per fatal crash avoided and approximately $110,000 per injury crash avoided. Appendix C explains the derivation of these values.

Table 30
Benefits of Options

	Fatalities Avoided	Fatal Crashes Avoided	Injuries Avoided	Injury Crashes Avoided	Total Benefits, 10 year, Bil, NPV
Option 1	38	32	985	676	$4.4
Option 2	38	32	985	676	$4.4
Option 3	57	48	1,478	1,014	$5.1
Option 4	83	70	2,153	1,744	$5.4
Option 5	115	98	2,995	2,514	$6.8

Table 31 repeats the benefits from the previous table, along with cost figures from Chapter 5. It shows that all options yield large net benefits, ranging from almost $1.7 billion for options 1 and 2 to $3.4 billion for option 5. Costs and benefits are for ten years, and discounted at a 7 percent rate. Figures do not add because of rounding.

Table 31
Costs and Benefits

	Discounted Benefits, Billions	Discounted Costs, Billions	Net Benefits, Billions
[redacted]	$4.418	$2.696	$1.721
[redacted]on 2	$4.418	$2.696	$1.721
[redacted]	$5.059	$2.636	$2.423
[redacted]on 4	$5.364	$3.083	$2.281
[redacted]	$6.803	$3.444	$3.359

The costs and benefits of options 1 and 2 are identical, with net benefits of $1.7 billion. Although, as discussed in chapter 5, the flexibility of option 2 might lower motor carrier costs somewhat, no attempt was made to quantify lower costs. Option 3 has greater benefits and similar costs, resulting in net benefits of more than $2.4 billion. Option 4 yields a net benefit of almost $2.3 billion, while option 5 has the highest net benefits at almost $3.4 billion.

Thirty percent of the benefit of options 1 and 2 is due to the reduction in crashes, with the remaining 70 percent accounted for by paperwork savings. Forty percent of the benefit of option 3 is due to the reduction in crashes, with the extra 2.5 percent assumed reduction in crashes of option 3 accounting for this difference. Approximately fifty percent of the benefit of options 4 and 5 results from the reduction in crashes. Table 32 displays the costs and benefits of the proposals excluding this paperwork benefit.

Table 32
Costs and Benefits Excluding Paperwork Benefits

	Discounted Benefits, Billions	Discounted Costs, Billions	Net Benefits, Millions
Option 1	$1.283	$2.696	-$1.413
Option 2	$1.283	$2.696	-$1.413
Option 3	$1.925	$2.636	-$.711
Option 4	$2.619	$3.083	-$.465
Option 5	$3.597	$3.444	$153

Ignoring the paperwork benefits does not affect costs. However, the impact on benefits is substantial The resulting reduction in benefits lowers net benefits for all options, with options 1 through 4 yielding net costs.

Table 33 shows the marginal costs, benefits and net benefits of moving from one option to a more stringent option. For all the changes in the table, costs increase, but not as much as benefits, so net benefits also rise. Net benefits jump by one third between options 2 and 4, and almost double between options 2 and 5. Moving from option 4 to option 5 increases net benefits by one half

Table 33
Marginal Changes in Costs, Benefits, and Crashes

Change	Fatal Crashes	Costs, Millions	Benefits, Millions	Net Benefits, Millions	Net Benefits, no Paperwork
2 to 4	(343)	$387	$946	$559	$948
2 to 5	(597)	$748	$2,386	$1,638	$1,566
4 to 5	(254)	$361	$1,439	$1,079	$618

Lowering the assumed accident reduction rates reduces the net benefits of all options. Because paperwork savings constitute a large part of total benefits, a given percent reduction in crashes results in a smaller reduction in net benefits. Halving the assumed crash reduction rate for all options lowers the net benefits of options 1 and 2 by approximately one third, and options 3, 4, and 5 by approximately 40 percent.

The analysis previously discussed the uncertainty concerning the percent of fatigue-related crashes. While the FMCSA estimates that 15 percent of all truck crashes are fatigue-related, analysts disagree about the precise figure. Accordingly, the following table shows the impact of lowering the baseline fatigue-related crash rate. Table 34 shows the costs, benefits, and reductions in accidents that would occur if 7.5 percent of all truck crashes were fatigue-related.

Table 34
Impact of 7.5 Percent Baseline Fatigue Related Crash Rate

	Fatal Crash Reduction	Injury Crash Reduction	Safety Benefits, Mil	Net Benefits, Mil
Option 1	16	338	$642	$1,080
Option 2	16	338	$642	$1,080
Option 3	24	507	$962	$1,461
Option 4	35	738	$1,341	$1,003
Option 5	48	1,027	$1,829	$1,591

Lowering the assumed fatigue-related crash rate reduces the benefits of all the options, but all options continue to show sizeable net benefits. Increasing the baseline fatigue-related crash rate obviously results in higher gross and net benefits.

Chapter 4 noted the uncertainty surrounding the price of EOBRs, with estimates ranging from $700 to $19,000 per unit. Because of doubt about the true cost, the FMCSA analyzed the consequences of higher and lower EOBR costs. Increasing the purchase price to $2,000 and the annual operating cost to $200 raises the cost of option 4 by almost $380 million, from $3.08 billion to $3.46 billion. Benefits continue to exceed costs, with net benefits of $1.9 billion. Excluding paperwork benefits, costs exceed benefits by $843 million over ten years For option 5, costs shoot up approximately three quarter of a billion dollars, to $4.167 billion, while net benefits fall by the same amount, to $2.6 billion.

The FMCSA also analyzed the impact of halving the cost of EOBRs, to $500 per unit and $50 per year. Not surprisingly, costs for both options plummet. For option 4, costs falls by almost $189 million, and net benefits increase by that amount. The cost of option 5 declines by approximately $362 million, and net benefits increase commensurately. Neither option appears to be overly sensitive to changes in the cost of EOBRs. Only when the cost of EOBRs reaches $6,000 does the cost of option 5 equal the benefits. For option 4, the breakeven EOBR cost is approximately $7,000.

The effectiveness of EOBRs in reducing fatigue-related crashes is also subject to disagreement. The Agency argued in Chapter 4 that drivers of vehicles with an EOBR will have 20 percent fewer fatigue-related crashes than those without the devices, because EOBRs will enhance enforcement officers capabilities to detect violations and will thereby increase compliance. However, the FMCSA also evaluated the impact of varying the assumed level of reduction in fatigue-related crashes brought on by EOBRs.

Table 35 shows the costs, benefits and number of accident that would be avoided if EOBRs only reduced fatigue-related crashes by 10 percent. Costs are unchanged, but fewer accidents are avoided, so total and net benefits drop for options 4 and 5. Benefits for both options remain positive. However, the net benefit of option 4 falls by $900 million, and that of option 5 by $1.5 billion. The net benefit of option 4, $1.34 billion, is less than that of options 1, 2 and 3. The new benefit of option 5 exceeds that of all options except option 3.

Table 35
Impact of Reducing EOBR Crash Reduction Rate to 10 Percent

	Fatal Crash Reduction	Injury Crash Reduction	Safety Benefits, Mil	Net Benefits, Mil
Option 4	44	943	$1,717	$1,379
Option 5	53	1,135	$2,054	$1,816

As discussed above, there is no directly observable data on people who might become truck drivers under different assumed wages. The FMCSA used an elasticity of 10 to estimate the increase in wages that would be needed to entice people to become truck drivers. With a unit elasticity, the annual cost of the proposals skyrocket, increasing 5 or 6 fold. With these dramatic increases in cost, none of the options comes close to achieving a net benefit. Assuming a perfectly elastic labor supply, with an infinite elasticity, lowers the cost of all options significantly. Costs for options 1 through 4 fall by approximately one half, while the costs of option 5 fall by more than 40 percent. Option 5 experiences a lower percent reduction in costs because EOBRs make up a larger percent of their total costs.

Throughout this analysis, the FMCSA has used conservative numbers. The most important numbers concern the baseline number of crashes that are fatigue-related, and the percent reduction in crashes due to each option. In both of these cases, we have chosen values that are conservative but plausible. These figures are conservative in that they represent the low end of the plausible set of values, and therefore tend to results in a lower range of benefits. For example, if we assumed that 20 percent of all CMV crashes were fatigue-related, then any given level of crash reduction would result in more crashes avoided, and thus greater benefits.

Appendix A
Number of Truck Drivers and the Distribution of Travel

Number of Truck Drivers

While there are a number of sources of data on truck drivers, none is entirely appropriate for estimating the number of CDL and non-CDL drivers. The more well known sources are:

> Surveys from The Bureau of Labor Statistics (BLS) of the Department of Labor, including the Current Population Survey, the Occupational Employment Survey, and the Establishment Survey. These estimates are not internally consistent, so it is not clear which is their "best" estimate. There also appears to be definitional problems, specifically the cutoff weight of trucks and how they categorize individuals who do not drive full time.
> The Commercial Drivers License Information System (CDLIS), which includes only CDL drivers. This may bias the numbers downward, but CDLIS also includes many people who may not be driving or even alive, which would bias the estimate upwards The net bias is unknown.
>
> The MCMIS census, which suffers from similar problems. It includes carriers which are probably out of business, and driver information is missing from one-fourth to one-third of carriers on the file. In addition, most intrastate carriers are not on the MCMIS file. We do not know the relative magnitude of these biases.

Because of the limitations of each of these sources, the FMCSA based its estimate on information from the 1996 Controlled Substance and Alcohol survey, supplemented by data obtained from the MCMIS Census file. The MIS survey represents a statistical sample of several thousand motor carriers selected from the MCMIS Census tile. Driver information collected from the survey is more current and, hence, more accurate than similar information contained on the Census file.

A weighted estimate of the total number of CDL drivers can be developed directly from the MIS survey data, since each respondent is required to report its total number of CDL drivers on the MIS form. Using these data and sampling weights for the survey yields an estimate of 3.19 million CDL drivers for 1996. The total number of non-CDL drivers, however, cannot be estimated from this survey, since non-CDL driver counts are not collected on the survey form.

To estimate the total number of non-CDL drivers, the OMC used a multi-stage procedure. First, the ratio of CDL to non-CDL drivers on the MCMIS file was calculated, using all active carriers. 2.6 million drivers were repotted on the file, including 1.29 million CDL drivers and 1.3 1 non-CDL drivers. Next, the ratio of CDL to non-CDL drivers on MCMIS was coupled with the MIS survey estimate for the total number of CDL drivers, to produce an estimate of the total number of non-CDL drivers, as illustrated in the following calculations.

$$(1.29 / 1.31) = (3.19 / x)$$

x = 3.24 million non-CDL drivers, where

1.29 = CDL drivers from MCMIS,
1.3 1 = non-CDL drivers from MCMIS,
3.19 = CDL drivers from MIS survey.

Combining the estimate of 3.19 million CDL drivers with the additional estimate of 3.24 million non-CDL drivers produces a total estimate of 6.43 million large truck drivers subject to the hours of service regulations. It should be noted, however, that the MCMIS Census file is assumed to capture only a small fraction of carriers engaged in intrastate commerce only. Hence, the estimate may be downward biased.

Distribution of Drivers

The FMCSA is not aware of any reliable data on the travel characteristics of truck drivers. Instead, we used Census Bureau information on truck travel, and assumed that the travel characteristics of drivers matches that of trucks. The FMCSA relied on the Bureau's Truck Inventory and Use Survey (TIUS). TIUS is a sample of trucks registered in 1992. The survey covers vehicle ownership, use, and physical characteristics. Over one hundred and twenty thousand owners responded to the survey, from which the Census Bureau generated detailed national estimates of truck use and characteristics.

Initially, the OMC subset the TIUS file to include only vehicles with an average gross vehicle weight of over 10,000 pounds. (TIUS does not collect data on weight ratings). However, UMTRI has developed a more sophisticated TIUS filter, which was used instead of the gross vehicle weight. The UMTRI filter excluded vehicles with

a Polk Vehicle Identification Number (VIN) derived GVWR of 2 or less; and
a body type coded as pickup, van, minivan, sport utility, and station wagon on a truck chassis; and
empty weight less than 6,000 pounds, two-axles, and four tires; and
all reported miles off road.

The next step consisted of classifying each truck sampled in the survey into one of three travel categories: long haul, other and short haul. For each truck sampled, TIUS collects data on the percent of miles that are accounted for by different length trips, ranging from less than 50 miles from home base to 500 or more miles from home base. We aggregated the TIUS categories, to the percent of miles in trips of over 500 miles, in trips of 200 to 500 miles, and in trips of less than 200 miles. Vehicles were then assigned to a category based on the stratum with the largest percent of miles driven. Three categories were used: long haul, regional, and local trucks. Trucks with a majority of trips of over 500 miles were classified as long haul, those with a majority of trips of 200 to 500 miles as regional, and those with a majority of trips of under 200 miles were local. Local trucks were then divided into work and other trucks, as described below.

For example, a vehicle with 40% of miles in the over 500 mile category, and 30% in each of the other 2 categories would be defined as long haul. If the percent in 2 categories were equal, the truck was assumed to belong to the shorter of the 2 categories. For example, if long haul and regional were each 40%, and local 20%, we classified the vehicle as regional.

Mileage data were missing for approximately 6% of all trucks. We distributed these missing vehicles among distance categories based on the distribution for vehicles with non-missing data, shown in *Table 1*. Thus, we assumed that 1% of straight trucks with missing travel data were long haul, 6% were regional, and 93% were local.

Table A-l
Most common Travel Distance,
by Vehicle Type

Distance	**Percent Single-Unit**	**Percent Combination**
Long	1%	19%
Regional	6%	28%
Local	93%	53%

The next step was to distribute the local trucks between work trucks and other trucks. Although TIUS does not contain any direct data on whether a truck is used primarily for non-driving purposes, it does report the vehicle's major use, which we used as a proxy to assign categories to local vehicles. The FMCSA assumed that all combination trucks which were local were other, since it is extremely unlikely that carriers would use a combination truck for something other that trucking. The price, size, and operating capabilities of combination trucks makes them extremely inefficient for non-driving purposes, or for the frequently-stopped operations typical of work trucks. This is not the case for straight trucks, however. Casual observation suggests that many straight trucks are used primarily for non-trucking purposes. Thus, we assumed that all local straight trucks for which the major use is either utility or contractor are work trucks. We also assumed half of the local straight trucks with a major use of construction work, business and personal services, retail trade, and other, were work trucks. For all other major uses, we assumed straight trucks were local, non-work. *Table* 2 shows the percent of straight trucks we assumed were work truck, by major use.

Table A-2
Percent Local Trucks Assumed Work Trucks,
by Major Use

Major Use	**Percent Work**
Agricultural Services	0%
Forestry @Lumbering Activities	0%
Construction Work	50%
Contracting Activities or Special Trades	100%
Manufacturing, Refining, Processing	0%
Wholesale Trade	0%
Retail Trade	50%
Business and Personal Services	50%
Utilities	100%
Mining Quarrying	0%
Daily Rental	0%
Not in use	0%
For hire	0%
Other	50%
One way rental	0%
Personal Transportation	0%

Finally, we combined the information above to come up with the overall travel distribution of truck drivers shown in Table A-3. No estimate of split shift drivers is provided. Only school and intracity (primarily transit) bus drivers operate on a split shift, but neither of these categories of drivers is covered by the HOS regulations. Because we could not ascertain whether any other type of drivers have split shift operations, we did not attempt to provide an estimate for these drivers. We also assumed that bus drivers are distributed similarly to truck drivers. While this assumption can be challenged, we have no other basis on which to distribute bus drivers. Furthermore, the Bureau of Transportation Statistics

(BTS) reports only 24,000 intercity and rural bus drivers in 1994, who are the only bus drivers subject to the HOS regulations. Alternative distributions would have a minimal impact on the final estimate.

Table A-3
Percent of Vehicles by Distance Category

Trip Category	**Percent**
Work	18.5%
Local, non-work	62.1%
Regional	12.8%
Long Haul	6.6%

These percentages were then multiplied by the estimated 6.43 million total drivers The results of this calculation are reported in Table A-4 below.

Table A-4
Number of Drivers by Distance Category

Trip Category	**Number**
Work	1,190,740
Local, non-work	3,997,023
Regional	823,863
Long-Haul	424,804
Total	6,436,430

Appendix B

Exposure and Fatigue Risk

Fatal accident involvement rates per 100 million vehicles miles traveled and per million registered trucks were calculated using the 1991-1996 TIFA data and the 1992 TIUS data. These rates may be useful to estimate the safety impact of the proposed HOS options. The results also illustrate the variation in the risk of truck driver fatigue for the different operating environments and industry segments that can be identified in both the TIFA and TIUS files. These factors are limited to power unit type (straight/tractor), trip distance, and carrier type (private/for-hire). Missing data on the variable in the 1992 TIUS identifying interstate carriers was so large that this information is not usable. Exposure data are not available on other important factors such as time of day and hours driving.

Three measures of risk were explored. The probability of fatigue given involvement in a fatal accident was scaled by the overall probability of fatigue and presented as the relative risk of fatigue, given involvement in a fatal accident. This calculation requires only accident data. This measure is of interest because time of day, hours driving, and other factors are available in the TIFA data, but exposure information is not available. For the factors available in both TIFA and TIUS, two accident rates were calculated. The first is the overall rate (per 100 million miles traveled) for involvement in any fatal accident, and the second is the rate for only truck driver fatigue when involved in a fatal accident. These three rates are related as follows:

Relative risk of fatigue in a fatal accident = (relative risk of fatal accident involvement) x (relative risk of fatigue given fatal involvement)

This relationship is illustrated in Table B-l. The rates in each row were calculated as described. The table illustrates that in each column, the bottom row is equal to the product of the first two rows. The relevance of this table is to assess whether the first row, which is based only on accident data, provides useful information on the risk of fatigue based on exposure, as shown in the last row. For the variables available, it seems that it does. The variation in relative risk in the first row is quite similar to the last row

Table B-l
Relation of Relative Risk Measures

	Straight			Tractor			Total
Risk	Work	Other	Long Haul	Work	Other	Long Haul	
Risk of Fatigue Given Fatal Acc Involvement	0.22	1.61	2.97	0.19	0.77	1.93	1.00
Risk of Fatal Acc Involvement per VMT	1.23	0.47	0.90	2.19	0.92	0.84	1.00
Risk of Fatigue per VMT	0.27	0.76	2.67	0.42	0.71	1.61	1.00

This result occurs because the variation in risk in the first row is larger than in the second, a range of about 15: 1 as compared to about 4:1. There are only two columns, straight trucks in the 50-100 mile category and local tractors where the second row significantly modifies the risk values from the first row. However, the overall pattern remains the same. This result suggests that the relative risk of fatigue given involvement in a fatal accident can provide useful information about the overall risk of fatigue for factors not available in existing exposure data.

The combination of the TIFA and TIUS data allowed rates per 100 million vehicle miles traveled and per million trucks for truck driver fatigue involvement in fatal accidents to be calculated for each combination of 3 important factors: power unit type (straight/tractor), trip distance, and carrier type (private/for-hire). Similar patterns in the relationship of these factors to the risk of fatigue were found in both the rates per trip and per truck. Trip distance, as might be expected, shows a substantial affect. Looking at the 5 level classification, trips with one way distances of 200–500 miles and trips over 500 miles one way both show substantial over involvement, 1.49 and 1.73 respectively. Underlying factors that are associated with trip distance are more likely to be responsible for the increased risk of fatigue on longer trips. Two such factors examined in Chapter 3 are time of day and hours driving. Local trips occur primarily during the daylight (and drivers presumably sleep more at night) whereas long haul trips involve more night travel. Local travel also seldom requires more than 8 hours of driving while long haul trips are more likely to involve more than 8 hours driving.

In addition to trip distance, power unit type is also associated with the risk of truck driver fatigue per mile traveled or per truck. Straight trucks and tractors both have relatively low risks of fatigue involvement in local and short trips. However, straight trucks on long trips have a substantially higher risk of fatigue than tractors. The results are somewhat mixed in the 5 level trip distance classification, but the fatigue risk for straight trucks is 66 percent higher than tractors in trips over 200 miles (one way). While tractors are better designed for long haul service, a more likely explanation is that straight truck drivers are less experienced in long haul trips and the associated fatigue than tractor drivers. Straight trucks on trips greater than 200 miles account for less than 5 percent of all truck driver fatigue in fatal accidents. As can be seen in the earlier part of this section, the exposure of straight trucks in long haul service is very low.

Carrier type is the last factor that could be examined with exposure based rates. This factor shows the strongest association with fatigue. Overall the truck driver fatigue rate per mile traveled for for-hire carriers is nearly 3 time that of private carriers. This difference is in part due to the large number of straight trucks in local service operated by private carriers. However, for-hire tractors in long haul service (trips over 200 miles one way) also have a risk of fatigue that is 2.7 time that of private carriers on a per mile basis. Results in the docket show that for-hire carriers in interstate service are involved in about 3 time as many fatal accidents at night as private carriers, and the relative risk of fatigue given involvement in a fatal accident from midnight to 6am is 3 to 5 times higher for interstate for-hire carriers than interstate private carrier. There may be other factors associated with for-hire carriers such as irregular shifts or longer work weeks that may contribute to fatigue, but cannot be addressed in the TIFA or TIUS data.

Separate sets of rates were calculated using both travel (100 million vehicle miles traveled) and truck population (million registered trucks) as exposure measures. These two measures differ substantially because there is wide variation in annual mileage ranging from straight trucks in local service to long haul tractors. Consequently, the overall rates for involvement in any fatal accident look quite different depending on the exposure measure used. The interesting finding is that the risk of fatigue when involved in a fatal accident follows essentially the same pattern regardless of the exposure measure used. Again, this result is a consequence of the strength of the relationship of fatigue to the factors examined. This finding underscores the importance of the link between the various operating environments and fatigue.

Appendix C
Cost of Injury Crashes

While fatalities are essentially equivalent in terms of cost and pain inflicted, injuries are largely incommensurable. An injury resulting in a severed spinal cord is clearly more significant, and costly, than one in which a tooth is broken. The Abbreviated Injury Scale (AIS) was developed by the American Medical Association and the American Association for Automotive Medicine to measure the threat to life of an accident. The MAIS refers to the maximum (most severe) injury sustained in a crash. The scale ranges from 0 for no injury to 6 for a fatality. The box below, which is adapted from a table on page 10 of Miller et al.'s *The Cost of Highway Crashes* (1991), illustrates the AIS scale with examples.

Table C-l
Abbreviated Injury Scale

AIS	Meaning	Example
0	Uninjured	
1	Minor injury	Whiplash, bruise, broken tooth
2	Moderate injury	Closed leg fracture
3	Serious injury	Open leg fracture, major nerve laceration
4	Severe Injury	Partial spinal cord severance, concussion with neurological signs (unconscious < 24 hours)
5	Critical injury	Complete spinal cord severance, concussion with neurological signs (unconscious > 24 hours)
6	Maximum injury (fatality)	Decapitation

To distribute injury accidents across the severity spectrum, we used data from NHTSA's *Heavy Duty Trucks in Crashes NASS 1979-1986*. This study presents extensive information from the National Accident Sampling System (NASS) for the years indicated, which were the only years in which NASS included heavy truck accident data. While it does not report the distribution of AIS injuries for all truck crashes, it contains several charts from which this data can be extracted.

Specifically, tables 24 and 25 from the report, reprinted below as tables C-2 and C-3, give the percent distribution of injuries of different AIS levels by functional class for truck occupants and others, respectively. The leftmost column represents the percent of total accidents on that road class, and the cell gives the percent of that road classes' accidents which result in injuries of that level of severity. For example, table C-l shows that 12% of the 24,826 truck occupant injuries occurred on rural interstates, and that 15.5% of these accidents resulted in AIS 1 injuries. Altogether, data from over 62,000 truck crashes are included, although the vast majority did not result in an injury. Because more serious injuries are very rare, they were added together in the NASS report.

Table C-2
Injury Severity of Truck Occupants

	Total	AIS 0	AIS 1	AIS 2	AIS 3+
Rural					
Interstate	12%	80.5%	15.5%	2.4%	1.6%
Principal Arterial	8%	80.9%	15.2%	2.0%	1.8%
Minor Arterial	6%	81.5%	15.9%	1.5%	1.0%
Major Collector	3%	83.4%	13.1%	2.2%	1.3%
Minor Collector	4%	88.6%	8.6%	1.7%	1.1%
Local	2%	92.8%	5.4%	1.3%	0.5%
Urban					
Interstate	13%	86.4%	10.8%	1.7%	1.1%
Freeway	3%	90.2%	8.5%	1.1%	0.3%
Principal Arterial	21%	94.5%	5.2%	0.2%	0.1%
Minor Arterial	13%	94.7%	3.9%	0.9%	0.5%
Collector	4%	94.1%	3.9%	1.5%	0.5%
Local	11%	98.0%	1.8%	0.1%	0.1%

Table C-3
Injury Severity of Other Vehicle Occupants

	Total	AIS 0	AIS 1	AIS 2	AIS 3+
Rural					
Interstate	6%	71.5%	24.5%	2.0%	2.0%
Principal Arterial	5%	67.8%	22.9%	4.3%	5.1%
Minor Arterial	4%	68.6%	23.5%	3.3%	4.6%
Major Collector	5%	80.3%	14.9%	3.0%	1.8%
Minor Collector	5%	78.3%	17.9%	2.0%	1.8%
Local	4%	86.3%	10.6%	2.2%	0.9%
Urban					
Interstate	9%	71.8%	23.9%	2.6%	1.6%
Freeway	2%	73.4%	23.6%	1.7%	1.3%
Principal Arterial	23%	75.8%	20.3%	2.9%	1.0%
Minor Arterial	16%	80.3%	16.2%	2.2%	1.3%
Collector	7%	86.7%	11.5%	1.0%	0.8%
Local	13%	83.7%	14.7%	1.0%	0.6%

Since the NASS report contains the percentage of accidents only, we had to perform some intermediate calculations to arrive at a combined total. Specifically, we multiplied the percentages by n, the number of accidents on which those percents were based, which resulted in cardinal numbers for each cell. We then added the two tables together, and subtracted out the number of AIS Os, since they are uninjured. Rows were summed, since this analysis does not focus on injuries by road class. We then calculated the percentage of different AIS level accidents for the combined table, and multiplied the percentages by the overall number of injuries to obtain estimates of the number of injuries that are AIS 1, AIS 2, and AIS 3+.

Table C-4 shows the results of this calculation, indicating that 82% of the injuries were AIS 1, 11% were AIS 2, and 7% were AIS 3 through 6.

Table C-4
Estimated Distribution of Heavy Vehicle Injuries

	AIS 1	AIS 2	AIS 3+
Distribution of Injuries	82.39%	10.63%	6.97%

The next step was to calculate the monetary benefit of preventing injury-causing accidents. Determining this value poses a number of difficulties. While some direct costs, such as the costs of hospitalization, are fairly easy to estimate, others are more subjective. This is especially the case for estimates of the costs of pain, suffering, and the diminished value of life. Most people would agree that pain from injuries imposes real costs on those injured, indeed, people pay extra money for safety equipment (air bags or fire detectors) to avoid incurring these costs. Nonetheless, establishing the true value of these indirect costs is difficult.

Economists attempt to value the benefits of reduced injuries and fatalities by observing how the market for safety works. There are several approaches to this. One method is to calculate how much people actually spend on devices which reduce the chances of dying by a given percent. For example, if 1 million people spent $10 each on fire detectors, which would result in saving one statistical life, the implicit value of deterring one fatality would be $10 million. Economists also estimate the premium which is paid to workers in high risk occupations, and calculate the values implicit in that premium.

In *The Cost of Highway Crushes,* Miller et al. performed a comprehensive analysis of the cost of fatalities and injuries from highway crashes, and his values are used in this evaluation. Table C-5 reprints part of Miller's Table 40, costs per injury in police reported crashes. Direct costs, such as emergency services, hospital and medical costs, and insurance administration, were obtained from a variety of sources, including industry association estimates.

Miller also included 2 types of indirect costs, lost productivity and pain and suffering. Lost productivity includes the wages and household productivity foregone because of an injury Miller estimated the number of days (or years) of work a victim would miss because of involvement in a crash, plus the amount of time a person would suffer diminished productive capacity (because of limited mobility, for example). Miller reviewed 47 credible studies of the cost of pain and suffering from injuries. These estimates, from the economic literature, were derived as explained above. Because the DOT uses a figure of 2.7 million per statistical fatality avoided, these calculations of Millers were not included in this analysis.

Several modifications were made to Miller's data. First, we adjusted the numbers to account for the fact that truck crashes impose greater costs than do crashes in which trucks are not involved. Specifically, emergency services, travel delay, and property damage were all trebled because of extra truck costs. These revised figures are presented in table C-6.

Second, Miller's costs are in 1988 dollars, so we inflated them to current, 1998 values. Hospital and medical, and vocational rehabilitation costs were inflated using the consumer price index for medical care. All values were inflated using the Consumer Price Index for all items, from the *1998 Economic Report of the President.* Inflated, 1998 values for all cost components are presented in table C-7, below.

Third, Millers costs are per fatality or injured person, but many crashes result in more than one injury or fatality. Between 1988 and 1997, there were 1.17 fatalities for each truck-involved fatal crash, and 1.458 injuries per injury crash. Therefore, we multiplied the 1998 values by 1.17 and 1.458 for fatalities and injuries to account for the extra per-crash costs.

Finally, we multiplied the injury costs by the percent distribution of injuries of different severity levels, from table C-4. This resulted in an estimated cost of $109,894 per injury crash, and $3,388,304 per fatal crash.

Table C-5

Unadjusted Figures from Table 40, The Costs of Highway Crashes, Miller et al, 1990

	Hosp/ Med	Voc Rehab	HH Prod	Wages	Insur Admin	Wkplc cost	Emerg Svcs	Travel Delay	Legal/ court	Prop Damage	Pain/ Suffer
MAIS 1	583	12	0	0	387	144	121	160	268	2605	2793
MAIS 2	4697	79	0	0	1615	1092	269	160	1936	2679	75999
MAIS 3	15822	170	0	0	5280	2433	404	160	9151	4607	290898
MAIS 4	48553	222	0	0	10700	2651	919	160	18198	6668	784160
MAIS 5	212628	423	0	0	41095	4695	935	160	68835	6400	1394675
FATAL	5859	0	0	0	46540	6186	842	160	64205	7294	1743917
MAIS 1-2	1070	20	0	0	532	256	139	160	466	2614	11465
MAIS 3-5	30370	190	0	0	7870	2583	489	160	13469	4927	405395

Table C-6

Adjustments to Table 1 for Truck Factors

	Hosp/ Med	Voc Rehab	HH Prod	Wages	Insur Admin	Wkplc cost	Emerg Svcs	Travel Delay	Legal/ court	Prop Damage	Pain/ Suffer
MAIS 1	583	12	0	0	387	144	363	480	268	7815	2793
MAIS 2	4697	79	0	0	1615	1092	807	480	1936	8037	75999
MAIS 3	15822	170	0	0	5280	2433	1212	480	9151	13821	290898
MAIS 4	48553	222	0	0	10700	2651	2757	480	18198	20004	784160
MAIS 5	212628	423	0	0	41095	4695	2805	480	68835	19200	1394675
FATAL	5859	0	0	0	46540	6186	2526	480	64205	21882	1743917
MAIS 1-2	1070	20	0	0	532	256	417	480	466	7842	11465
MAIS 3-5	30370	190	0	0	7870	2583	1467	480	13469	14781	405395

Table C-7

Adjustments to Table 2 for Inflation from 1988 to 1998, from 1999 Economic Report of the President

	Hosp/ Med **	Voc Rehab **	HH Prod ***	Wages ***	Insur Admin *	Wkplc Cost •	Emerg Svcs *	Travel Delay •	Legal/ ♍□◆□◆ *	Prop Damage *	Pain/ Suffer *
MAIS 1	1018	21	0	0	533	198	500	661	369	10768	3848
MAIS 2	8205	138	0	0	2225	1505	1112	661	2668	11074	104715
MAIS 3	27637	297	0	0	7275	3352	1670	661	12609	19043	400815
MAIS 4	84810	388	0	0	14743	3653	3799	661	25074	27563	1080457
MAIS 5	371409	739	0	0	56623	6469	3865	661	94845	26455	1921657
FATAL	10234	0	0	0	64125	8523	3480	661	88465	30150	2700000
MAIS 1-2	1869	35	0	0	733	353	575	661	642	10805	15797
MAIS 3-5	53049	332	0	0	10844	3559	2021	661	18558	20366	558575

Table C-8
Final Adjustments

	Total (from C-7)	Injury Severity Distribution	Adjusted Injury Cost	People Injured & Killed per Crash	Adjusted Cost, Final
MAIS 1	17916	82.39%	14760.99		
MAIS 2	132303	10.63%	14063.81		
MAIS 3	473359				
MAIS 4	1241148				
MAIS 5	2482723				
FATAL	2905638			1.17137	$3,388,304
MAIS 1-2	31470				
MAIS 3-5	667965	6.97%	46557.16		
All Injuries		100.00%	75381.96	1.45783	$109,894

Appendix D

Selected Bibliography

Abrams, C., T. Schultz, C.D. Wylie, Commercial Motor Vehicle Driver Fatigue, Alertness, and Countermeasures Survey, August 1997, report for FHWA, FHWA-MC-99-067

Belzer, Michael H. 1995. *Collective Bargaining After Deregulation: Do the Teamsters Still Count?* Industrial and Labor Relations Review 48, 636-655

Blower, Dan *The Relative Contribution of Truck Drivers and Passenger Vehicle Drivers to Track-Passenger Vehicle Traffic Crashes,* June 1998

Blundell, Richard and Thomas Macurdy, *The Supply Side,* in Ashenfelter and Card, Handbook of Labor Economics, Volume 3A (Elsevier, 1999)

Brown, *Ivan, Driver Fatigue,* Human Factors, 1994, 36(2), 298-314

Brown, Charles and James Medoff, *The Employer* Size *Wage Effect,* Journal of Political Economy 97 (1989)

Cambell, Keneth L., Sylvia W. Lang, and Michael Smith, *Electronic Recorder Study,* FHWA-MC-99-059, June 1998

Deering, R.K., General Motors Safety Center, Crash Avoidance Technologies to Assist the Driver, Presentation at American Society of Civil Engineers Conference, May 17, 1994

Dinges, David F., *An Overview of Sleepiness and Accidents,* Journal of Sleep Research 4 1995, (suppl. 2)

J.M. Dutton and A. Thomas, *Academy of Management Review,* Rev. 9, 235, 1984

Engel, Cynthia, *Competition Drives the Trucking Industry,* Monthly Labor Review, April 1998

Expert Panel, Hours-of-Service Regulations for Commercial Drivers, September 1998

Folkard, Simon, *Black Times: Temporal Determinants of Transport Safety,* Accident Analysis and Prevention, 1997, 29:4, 417-430

Galloway, Marsh, *Insights on Driver Retention Problem,* Transport Topics, December 18, 1995, 21-22

Gallup Organization, Empty Seats and Musical Chairs : Critical Success Factors in Truck Driver Retention, October 1997

Hirsch, Barry T and David A Macpherson, Earnings and Employment in Trucking: Deregulating a Naturally Competitive Industry, in James A People ed. Regulatory Reform and Labor Markets, Kluwer, 1998

Johnson D., D. Thorne, L. Rowlamd, T. Balkin, H. Sing, M. Thomas, M. Wesenten, D. Redmond, M. Russo, R. Aladdin, R. Cephus, S. Hall, J. Powell, D. Dinges, G. Belenky, The Effects of Partial Sleep Deprivation on Psychomotor Vigilance

Lin, Tzuoo-Ding, Paul P Jovanis, and Chun-Zin Yang, *Modeling the Safety of Truck Driver Service Hours Using Time-Dependent Logistic Regression,* Transportation Research Record 1047, 1994

Massie, Dawn L., Daniel Blower, and Kenneth Campbell, *Short Haul Trucks and Driver Fatigue,* September 1997, FHWA-MC-98-016

McCart, Anne T., Mark C. Hammer, and Sandra Z. Fuller, Study of Fatigue-Related Driving Among Long-Distance Truck Drivers in New York *State,* Volume 1: Survey of Long Distance Truck Drivers, August 1997, Institute for Trraffic Safety Management and Research

McElroy, James C, Julene M. Rodriguez, Gene C. Griffin, Paula C. Morrow, and Michael G. Wilson, *Career Stage, Time Spent on the Road, and Truckload Driver Attitudes,* Transportation Journal, Fall 1993, 5-14

McGraw-Hill Companies and US Department of Commerce, International Trade Administration, *U.S. Industry and Trade Outlook '99* (1999)

Miller, Ted, J. Viner, S. Rossman, N. Pindus, W. Gellert, J. Douglas, A. Dillingham, and G. Bloomquist, The Costs of Highway Crashes, October 1991, The Urban Institute, FHWA-RD-91-055

Najm, W.G., M. Mironer, J.S. Koziol Jr., J.S. Wang, and R.R. Knipling, Examination of Target Vehicular Crashes and Potential ITS Countermeasures, report for Volpe National Transportation Systems Center, DOT HS 808 263, June 1995

Peters, Robert D., Esther Wagner, Elizabeth Alicandri, Jean E. Fox, Maria L. Thomas, David R. Thorne, Helen C. Sing, Sharon M. Balwinski, *Effects of Partial and Total Sleep Deprivation on Driving Performance,* Public Roads, January/February 1999

Peoples, James, *Deregulation and the Labor Market,* Journal of Economic Perspectives, Summer 1998, 12, 111-130

Pilcher, J.J., and A.I. Hufcutt, *Effects of Sleep Deprivation on Performance: A Meta-Analysis*, Sleep 19:4, 318-326, (1996)

Transport Topics Online (WWW.TTnews.com) *Truck Stops Join the Battlefor Driver Retention,* December 28, 1998

Transport Topics Online (WWW.TTnews.com) *Editorial: Where to Find Tomorrows Truckers,* March 9, 1999

Traffic World, *Lumping, Long Hours, Absencefrom Home Continue to Fuel Truckload Driver Shortage,* February 14, 1994

Treat, J.R., Tumbas, N.S., McDonald, S.T., Shinar, D., Hume, R.D., Mayer, R.E., Stansifer, R.L., & Catellan, N.J. *Tri-Level Study of the Causes of Traffic Accidents: Final Report Volume I: Causal Factor Tabulations and Assessments,* Institute for Research in Public Safety, Indiana University, DOT Publication No. DOT HS-805 085, 1979

US Coast Guard, Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Maritime Casualties, 1997, Report MSC 68/INF/

Viscusi, W. Kip, *The Value of Risks to Life and Health,* December 1993, Journal of Economic Literature

C.D. Wylie, T. Shultz, J.C. Miller, M..M. Mitler, R.R. Mackie, Commercial Motor Vehicle Driver Fatigue and Alertness Study: Project Report, October 1996, FHWA-MC-97-002

C.D. Wylie and RR Mackie, Stress and Sonar Operator Performance: Enhancing Target Detection Performance by means of Signal Injection and Feedback, 1988, Essex Corporation, Human Factors Research Division

Initial Regulatory Flexibility Analysis

The Regulatory Flexibility Act seeks to ensure that federal agencies take small businesses' particular concerns into account when developing, writing, publicizing, promulgating and enforcing regulations. To achieve this, the Act requires agencies to detail how they have met these concerns, by including a Regulatory Flexibility Analysis (RFA). An initial RFA, which accompanies a NPRM, must include the following six elements:

1) a description of the reasons why action by the agency is being considered;

2) a succinct statement of the objectives of, and legal basis for, the proposed rule;

3) a description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;

4) a description of the proposed reporting, recordkeeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities which will be subject to the requirements and the type of professional skills necessary for preparation of the report or record;

5) an identification, to the extent practicable, of all federal rules which may duplicate, overlap, or conflict with the proposed rule; and

6) a description of any significant alternatives to the proposed rule which accomplish the stated objectives of applicable statutes and which minimize and significant economic impact of the proposed rule on small entities.

The FMCSA's analysis of these items follows. Additional information on the small business impacts of options 4 and 5 may be found on page 59 of the accompanying regulatory evaluation.

I) A description of the reasons why action by the agency is being considered.

The Agency developed these options because of Congressional action and independent safety concerns. Section 408 of the ICC Termination Act of 1995 directs the FHWA to issue an ANPRM and NPRM "dealing with a variety of fatigue-related issues pertaining to commercial motor vehicle safety (including 8 hours of continuous sleep after 10 hours of driving...and other appropriate regulatory and enforcement countermeasures for reducing fatigue-related incidents and increasing driver alertness)". In addition, evidence suggests that fatigue continues to be an important contributing factor in some CMV crashes. The Agency believes that updating the regulations to reflect advances in understanding of sleep and fatigue will increase compliance with the regulations, ease enforcement, and enhance overall highway safety.

2) A succinct statement of the objectives of, and legal basis for, the proposed rule.

The objective of these proposals is to ensure that drivers are adequately rested before driving CMVs. The proposals seek to do this by increasing the continuous off-duty periods of time afforded to drivers to obtain sleep, providing additional opportunities for some categories of drivers to obtain rest during breaks, and improving the daily sleep-wake cycle to correspond more closely with circadian rhytymicity. The proposals also seek to minimize the paperwork burden on carriers by eliminating the RODS for many drivers.

The legal basis for the rule, in addition to the provisions of the ICC Termination Act cited above, include the Motor Carrier Act of 1935, codified at 49 USC 3 1502(a), the Migrant Farm Workers-Regulation of Interstate Transportation Act of 1956, 49 USC 31502(b), the Motor Carrier Safety Act of 1984, 49 USC 3 1136, Section 113 of the Hazardous Materials Transportation Authorization Act (HMTAA) of 1994, and Section 345 of the National Highway System Designation Act (NHSDA) of 1995.

The HMTAA instructs the FHWA to issue regulations improving "(A) compliance by commercial motor vehicle drivers and motor carriers with hours of service requirements; and (B) the effectiveness and efficiency if Federal and States enforcement officers reviewing such compliance".

3) A description of and, where feasible. an estimate of the number of small entities to which the proposed rule will apply

These proposals would apply to a large number of small carriers. Of the 497,000 motor carriers on the Motor Carrier Management Information System (MCMIS) census file, almost 250,000 own 6 or fewer power-units, 50 percent of the total. These 250,000 motor carriers own approximately 703,000 power-units, an average of about almost 3 per carrier, accounting for approximately 22.5% of all power-units on MCMIS.

Not all of these motor *carriers* are considered small businesses under the definitions issued by the Small Business Administration (SBA). The SBA defines a small business as one with annual gross receipts of less than $18.5 million. We do not know what percentage of motor carriers tit into this category While it is likely that the majority of motor carriers with fewer than 6 drivers have gross receipts of less than $18.5 million, the Agency believes some of them surpass that revenue threshold. The FMCSA's safety regulations apply to all operators of CMVs in interstate commerce, not only traditional motor carriers. Some of these CMV operators may make the majority of their revenue from non-trucking sources, but only *own* 2 or 3 CMVs. Examples include musicians who own buses for transportation between performances, or millwork distributors which operate a few CMVs to distribute finished millwork. While the small number of vehicles these operations own would suggest they are small entities, their gross revenues from non-trucking sources could result in their being classified as large entities.

In the attached regulatory evaluation, we estimated that option 5 would cost small long-haul and regional motor carriers $180 million undiscounted to purchase EOBRs, $152 million discounted. Annual costs equal $17.9 million undiscounted, for a total of approximately $103 million discounted over ten years.

EOBRs will cost the average small long-haul motor carrier $2,850 to purchase and $282 annually for maintenance (undiscounted).

Data on firms and receipts from the Small Business Administrations (SBA) web site show that for SIC codes 4200 through 4214, small motor carriers had average annual receipts of just over $400,000 in 1996. First year costs of $3,132 ($2,850+$282) equal approximately three fourths of one percent of the average small motor carriers receipts.

While overall costs are fairly high for small motor carriers, we believe it is likely that EOBR costs could be lower than estimated above. First, we assumed that small motor carriers would purchase one quarter of their EOBRs in each of the first four years. In reality, it is likely that most small motor carriers will wait until the latter years to buy an EOBR. This will lower the discounted EOBR costs, as later year purchases are discounted more highly than earlier ones. In addition, small motor carriers who purchase EOBRs in year 4 will have to pay for maintenance for 3 fewer years than those who purchase in the first year.

Second, the FMCSA believes it is likely that the price of EOBRs will fall as production increases. As manufacturers gain proficiency in producing a product, improved use of labor and material tend to lower the costs of productions. Improvements include reducing the number and complexity of component parts, improved production of components, improved assembly speed and processes, reduced error rates, and better manufacturing processes. In a 1984 study of 108 manufacturing items from 22 field studies, Dutton and Thomas found a progress ratio of slightly higher than 80 percent, which means that each doubling of cumulative production reduces the cost level by 20 percent (Dutton and Thomas). Because of the phase-in period for small motor carriers, larger motor carriers are likely to bear higher initial production costs.

Finally, many small motor carriers will be able to purchase EOBRs through larger motor carriers, thereby realizing the same scale economies as large motor carriers Anecdotal information suggests that a majority of owner-operators are on long term leases with large motor carriers. One source of this information was oral communication between the executive-director of the Owner-Operator Independent Drivers Association (OOIDA) and Department of Transportation staff. OOIDA's executive director estimated that 70 percent of owner-operators work as long-term contractors with other motor carriers. Many of these long-term contractors will presumably be able to purchase EOBRs at the same cost as the larger motor carriers to which they are contracted.

4) A description of the proposed reporting, recordkeeping and other compliance requirements of theproposed rule, including an estimate of the classes of small entities which will be subject to the requirements and the type ofprofessional skills necessary for preparation of the report or record

The FMCSA believes it needs the following seven recordkeeping requirements to monitor drivers compliance with the proposed options and achieve the program objectives for this NPRM.

1. The driver's name (or identifying symbol or number if motor carriers use such identifying codes in place of the name on any time or work records).

2. Time of day and day of week when the driver's workweek begins.

3. The daily starting time for each duty period. There could be multiple duty periods each workday requiring multiple starting times for each workday.

4. The daily stopping time for each duty period. There could be multiple duty periods each workday requiring multiple stopping times for each workday.

5. Hours worked each workday and total hours worked each workweek.

6. All basic time cards or sheets on which are entered the starting and stopping time of individual drivers.

7. Order, shipping and billing records retained or made in the usual course of business operations, From the last date of entry,
   a. Originals or true copies of all customer orders or invoices received.
   b. All incoming or outgoing shipping or delivery records.
   c. All bills of lading.
   d. All bills to customers (not including individual sales slips, cash register tapes or the like).

No special expertise would be required to complete the time card. All small entities would be subject to this report (which is less burdensome than the reports they are currently required to complete).

Under option 1, type I and type 2 drivers would be responsible for preparing the time record and allowing law enforcement officials at the roadside to review it when requested. In addition to the information required by the Department of Labor, this option would require type 1 and 2 drivers to record the locations of any changes of duty status. Type 1 drivers include drivers who operate interstate CMVs away from their residence more than three consecutive nights. Type 2 drivers are regional drivers, which consists of drivers who are away from home more than 1 but fewer than 3 consecutive workdays. Under this option, all other categories of drivers would have to complete a time record but would not have to maintain the record on their vehicles.

Under options 2 and 3, type 1 drivers may use an EOBR to record drivers hours of service. Drivers who use an EOBR would be able to work more hours and take advantage of the more flexible two-week schedule. These drivers would need some specialized expertise to use the EOBR, as would clerks and managers for companies which use the EOBR. Clerks and managers would need to learn how to download, analyze and store the data produced by the EOBRs.

Type1 drivers who do not use an EOBR would have to complete a modified DOL time card which includes the location of any changes of duty status, as is the case under option 1. All other drivers would be required to complete a DOL time card.

5) An identification, to the extent practicable, of allfederal rules which may duplicate, overlap, or conflict with the proposed rule.

The following seven statutes and rules may duplicate, overlap, or conflict with the current regulations, The FMCSA has attempted to minimize any duplication, overlap, and conflicts through the potential options.

1. The US Department of Labor's Wage and Hour Division (WHD) requires motor carriers to produce and retain the same seven pieces of information required by this proposed options for all employed drivers. The WHD requires information and data to be kept for driver-employees who are subject to any exemption provided in the Fair Labor Standards Act of 1938, as amended (FLSA). See 29 U.S.C. 201 et seq. and 29 CFR parts 516 and 782. The text of the 29 U.S.C. 213(b)(1) exemption is provided here.

   (b) The provisions of section 207 of this title shall not apply with respect to--

   > (1) any employee with respect to whom the Secretary of Transportation has power to establish qualifications and *maximum* hours of service pursuant to the provisions of section 3 1502 of title 49.

2. Another FLSA statute, 29 U.S.C. 211, explicitly requires motor carrier employers to make, keep, and preserve records for the hours worked by its employees, including its drivers. The text of 29 U.S.C. 21 l(c) follows.

   > (c) Records
   > Every employer subject to any provision of this chapter or of any order issued under this chapter shall make, keep, and preserve such records of the persons employed by him and of the wages, hours, and other conditions and practices of employment maintained by him, and shall preserve such records for such periods of time, and shall make such reports therefrom to the Administrator as he shall prescribe by regulation or order as necessary or appropriate for the enforcement of the provisions of this chapter or the regulations or orders thereunder.

3. No similar statute explicitly requires motor carriers to make, keep, or preserve records for hours worked by any employee with respect to whom the Secretary of Transportation has power to establish qualifications and maximum hours of service pursuant to the provisions of section 3 1 502 of title 49. However, both section 31502 and 49 U.S.C. 31136 provide authority broad enough to support any reasonable record-keeping requirement. The FMCSA, through delegations of

authority from the Secretary of Transportation, has general authority to require, access, and copy records. See the underlined phrases in the following paragraphs of 49 U.S.C. 502 and 504.

49 U.S.C. 502. General authority

(a) The Secretary of Transportation shall carry out this chapter.
(b) The Secretary may--
(1) inquire into and report on the management of the business of rail carriers and motor carriers;
(2) inquire into and report on the management of the business of a person controlling, controlled by, or under common control with those carriers to the extent that the business of the person is related to the management of the business of that carrier; and
(3) obtain from those carriers and persons information the Secretary determines to be necessary. (Emphasis added.)

49 U.S.C. 504

(b)(1) The Secretary of Transportation may prescribe the form of records required to be prepared or compiled under this section by-

(A) carriers and lessors; and
(B) a person furnishing cars or protective service against heat or cold to or for a rail carrier.
(2) The Secretary may require--
(A) carriers, lessors, associations, or classes of them as the Secretary may prescribe, to file annual, periodic, and special reports with the Secretary

containing answers to questions asked by the Secretary.

* * *

*

(c) The Secretary, or an employee designated by the Secretary, may on demand and display of proper credentials--

(1) inspect the equipment of a carrier or lessor; and

(2) inspect and copy any record of--

(A) a carrier, lessor, or association;

(B) a person controlling, controlled by, or under common control with a carrier, if the Secretary considers inspection relevant to that person's relation to, or transaction with, that carrier; and

(C) a person furnishing cars or protective service against heat or cold to or for a rail carrier if the Secretary prescribed the form of that record.

(d) The Secretary may prescribe the time period during which records must be preserved by a carrier, lessor. (Emphasis added.)

4. The first five items of the seven total items the FMCSA needs are in the following DOL regulations. See the following italicized text.

29 CFR 516.2 Employees subject to minimum wage or minimum wage and overtime provisions pursuant to section 6 or sections 6 and 7(a) of the Act.

(a) Items required. Every employer shall maintain and preserve payroll or other records containing the following information and data with respect to each employee to whom section 6 or both sections 6 and 7(a) of the Act apply:

(1) Name in full, as used for Social Security recordkeeping purposes, and on the same record, the employee's identifying symbol or number if such is used in place of name on any time, work, or payroll records,

(2) Home address, including zip code,

(3) Date of birth, if under 19,

(4) Sex and occupation in which employed (sex may be indicated by use of the prefixes Mr., Mrs., Miss., or Ms.) (Employee's sex identification is related to the equal pay provisions of the Act which are administered by the Equal Employment Opportunity Commission. Other equal pay recordkeeping requirements are contained in 29 CFR part 1620.)

(5) Time of day and day of week on which the employee's workweek begins (or for employees employed under section 7(k) of the Act, the starting time and 'length of each employee's work period). If the employee is part of a workforce or employed in or by an establishment all of whose workers have a workweek beginning at the same time on the same day, a single notation of the time of the day and beginnine day of the workweek for the whole workforce or establishment will suffice,

(6)(i) Regular hourly rate of pay for any workweek in which overtime compensation is due under section 7(a) of the Act,

(ii) explain basis of pay by indicating the monetary amount paid on a per hour, per day, per week, per piece, commission on sales, or other basis, and

(iii) the amount and nature of each payment which, pursuant to section 7(e) of the Act, is excluded from the "regular rate" (these records may be in the form of vouchers or other payment data),

(7) Hours worked each workday and total hours worked each workweek (for purposes of this section, a "workday" is any fixed period of 24 consecutive hours and a "workweek" is any fixed and regularly recurring period of 7 consecutive workdays),

(8) Total daily or weekly straight-time earnings or wages due for hours worked during the workday or work-week, exclusive of premium overtime compensation,

(9) Total premium pay for overtime hours. This amount excludes the straight-time earnings for overtime hours recorded under paragraph (a)(8) of this section,

(10) Total additions to or deductions from wages paid each pay period including employee purchase orders or wage assignments. Also, in individual employee records, the dates, amounts, and nature of the items which make up the total additions and deductions,

(11) Total wages paid each pay period,

(12) Date of payment and the pay period covered by payment.

5. Most motor carriers engaged in interstate commerce are exempt from recording items 29 CFR 516.2(a)(6) and 516.2(a)(9) for CMV drivers based upon their 29 U.S.C. 213(b)(1) exemption under the FLSA, though they are required to record information and data similar to 29 CFR 516.(a)(6)(ii). See the concluding phrase of 29 CFR 516.12, following this paragraph. Of course, these same motor carriers must record items 29 CFR 516.2(a)(6) and 516.2(a)(9) for all employees other than most interstate CMV drivers, including intrastate CMV drivers.

29 CFR 516.12 Employees exempt from overtime pay requirements pursuant to section 13(b) (1), (2), (3), (5), (9), (10), (15), (16), (17), (20), (21), (24), (27), or (28) of the Act.

With respect to each employee exempt from the overtime pay requirements of the Act pursuant to the provisions of section 13(b)(1), (2), (3), (5), (9), (10), (15), (16), (17), (20), (21), (24), (27), or (28) of the Act, [employers] shall maintain and preserve payroll or other records, containing all the information and data required by § 516.2(a) except paragraphs (a)(6) and (9) and, in addition, information and data regarding the basis on which wages are paid (such as the monetary amount paid, expressed as earnings per hour, per day, per week, etc.).

6. Motor carriers subject to the Motor Carrier Safety Act of 1984 (49 U.S.C. 31131 et seq.) which are not also subject to the Motor Carrier Act of 1935 (49 U.S.C 31502) are not covered under the 29 U.S.C. 213(b)(1) exemption, and therefore, are required to pay overtime to CMV drivers engaged in interstate commerce and must comply with 29 CFR 516.2(a)(6) and 516.2(a)(9). This group is confined to private motor carriers of passengers (e.g., churches, musicians, civic associations, scouts, charitable organizations, manufacturers transporting employees). See 59 FR 8748, February 23, 1994, for additional examples of private motor carriers of passengers.

7 The DOL regulations also specify other business records motor carriers need to preserve for at least two to three years. The last two of the eight items the FMCSA needs to monitor compliance are found in the following DOL regulations. See the italicized text of 29 CFR 516.6 restated here.

29 CFR 51

6.6 Records to be areserved 2 years.

(a) Supplementary basic records: Each employer required to maintain records under this part shall preserve for a period of at least 2 years.

(1) Basic employment and earnings records. From the date of last entry, all basic time and earning cards or sheets on which are entered the daily starting and stopping time of individual employees, or of separate work forces, or the amounts of work accomplished by

individual employees on a daily, weekly, or pay period basis (for example, units produced) when those amounts determine in whole or in part the pay period earnings or wages of those employees.
(2) Wage rate tables. From their last effective date, all tables *or* schedules of the employer which provide the piece rates or other rates used in computing straight-time earnings, wages, or salary, or overtime pay computation.
(b) Order. shipping. and billing records: From the last date of entry, the originals or true conies of all customer orders or invoices received. incoming or outgoing shinning or delivery records, as well as all ~~bills of lading and all billings to customers (not including~~ individual sales slips, cash register tapes or the like) which the employer retains or makes in the usual course of business operations.

(c) Records of additions to or deductions from wages paid:
(1) Those records relating to individual employees referred to in § 5 16.2(a)(10) and
(2) All records used by the employer in determining the original cost, operating and maintenance cost, and depreciation and interest charges, if such costs and charges are involved in the additions to *or* deductions from wages paid. (Emphasis added.)

Thus, the 29 CFR part 516 records could suffice for the FMCSA's driver monitoring and enforcement purposes. The FMCSA could rely upon DOL records exclusively (except for long haul drivers) and not require more burdensome, unnecessary records in specific formats, i.e., graph grids, automatic recorders, or smart cards. This would allow motor carriers to use any record of duty the carrier chooses to meet the program objectives and requirements of both agencies.

6) A description of any significant alternatives to the proposed rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the proposed rule on small entities.

This evaluation considered six alternatives, the status quo and options 1 through 5. The FMCSA narrowed these options from an initial menu of 8 alternatives. The most significant differences between the alternatives was the number of hours of on- and off- duty time allowed, the distinctions among categories of motor carriers, and the requirement to use an EOBR.

Because of the need for all drivers, regardless of the size of their employer, to meet a minimal level of safety, we did not propose special exemptions for small businesses. Data on motor carriers reviewed by the Department of Transportation between 1995 and 1999 show that small carriers have higher crash rates than their larger counterparts. Table RFA-1 shows the number of recordable and recordable preventable crashes for carriers reviewed by size class, and it reveals that carriers with 6 or fewer trucks have a crash rate of approximately 2 to 3 times higher than other motor carriers. Accordingly, it is inconsistent with congressional intent and the safety mandate of the agency to exempt small carriers from the provisions of this proposal.

Table RFA-1
Crashes by Motor Carrier Size

Number of Trucks	Recordable Crashes, per Million VMT	Recordable Preventable Crashes, per Million VMT
1 - 6	2.23	0.98
7 - 20	1.20	0.53
21 - 100	0.88	0.42
100 +	0.72	0.40

However, options 4 and 5 do allow small businesses 4 years to comply with the EOBR requirement. This additional time will allow small motor carriers extra time to plan to meet the EOBR requirements. Additionally, as discussed above, the FMCSA believes that it is likely that the costs of EOBRs will fall by the fourth year of this rule, as manufacturers take advantage of economies of scale in production.

Finally, it is important to note that all the options (except the status quo) will reduce the paperwork burden on carriers, regardless of size.

The FMCSA believes that this proposal will effect a substantial number of small entities. What we do not know with certainty is the full economic impact of the proposal on small entities. We, therefore, specifically request comments on the costs and impacts of this proposal on small entities. If, after receiving and reviewing public comments, our analysis indicates that the costs and impacts are comparable to those used in this analysis, the FMCSA would then certify that the final rule does not have a significant economic impact on a substantial number of small entities.

Regulatory Accountability and Reform Analyses

Introduction

The Unfunded Mandates Reform Act of 1995 (the Act) requires each agency to assess the effects of its regulatory actions on State, local, and tribal governments and the private sector. Any agency promulgating a final rule resulting in a Federal mandate requiring expenditure by a State, local or tribal government or by the private sector of $100,000,000 or more in any one year must prepare a written statement incorporating various assessments, estimates, and descriptions that are delineated in the Act. In light of the fact that revisions to the hours of service regulations will cost motor carriers more than $100,000,000 in a given year, the FMCSA has prepared the following statement which addresses each of the elements required by the Unfunded Mandates Reform Act of 1995. Most of these required elements have already been covered in the preliminary regulatory evaluation, and the sections of that evaluation containing the preexisting analyses are referenced in this statement. Any elements not included in the final regulatory evaluation have been addressed directly in this statement.

Authorizing Legislation

Section 202(a)(1) of the Act requires that the agency identify the provision of Federal law under which the rule is being promulgated. The FMCSA is issuing the final rule under 49 U.S.C. 31136 and 31502. The Federal Highway Administrator is delegated the authority to carry out the functions vested in the Secretary of Transportation by 49 U.S.C. 31136 and 31502. (49 CFR 1.48)

Required Analyses and Assessments

Qualitative and Quantitative Assessment of Costs and Benefits

The Act requires a qualitative and quantitative assessment of the anticipated costs and benefits of this Federal mandate. The options discussed in the NPRM will cost between $2.6 and $3.4 billion over ten years. Cost estimates are discussed in chapter 5. The cost applies only to motor carriers subject to the Federal Motor Carrier Safety Regulations. The final rule does not impose any cost on State, local, or tribal governments.

The FMCSA estimates that the lo-year discounted monetary value of the benefits (fatalities and injuries prevented, property damage savings) of this proposal ranges from $4.4 to $6.8 billion. The development of these estimates are discussed in chapter 4.

Effect on Health, Safety, and the Natural Environment

The Act also states that the effect of the Federal mandate on health, safety, and the natural environment must be discussed. The FMCSA does not believe that this proposal would have any impact on the natural environment.

The effects of this rule on health and safety will be much more significant: the primary benefit of this proposal would be a reduction in accidents, injuries and fatalities. The FMCSA estimates this rule will prevent between 38 and 115 fatalities annually, depending on which option chosen. Likewise, injuries will fall by 985 to 2,995. These estimates are explained in detail in Chapter 4 of the regulatory evaluation.

Federal Financial Assistance

Section 202(a)(2)(A) requires that this qualitative and quantitative assessment of costs and benefits include an analysis of the extent to which costs to State, local, and tribal governments may be paid with Federal financial assistance or otherwise paid for by the Federal Government. Since this rule is applicable only to motor carriers subject to the Federal Motor Carrier Safety Regulations, there is no cost to State, local, and tribal governments. Therefore, no Federal funds for these entities will be necessary for motor carriers to comply with the proposed requirements.

Future Compliance Costs

To the extent feasible, section 202(a)(3) requires estimates of the future compliance costs of this Federal mandate and any disproportionate budgetary effects upon particular regions, or upon urban, rural, or other types of communities, or upon particular segments of the private sector. There are no disproportionate budgetary effects upon particular regions, or upon urban, rural, or other types of communities. The budgetary effects depend on the number of motor carriers based in particular regions or certain communities. There is no data to suggest that economic impacts of this rule on any particular region or type of community will be disproportionate.

Effect on the National Economy

Section 202(a)(4) requires estimates of the effect on the national economy, such as the effect on economic growth, full employment, creation of productive jobs, and international competitiveness. It is estimated that this rule will cost the public between $2.6 and $3.4 billion over a 10-year period, depending on the option. Because the overall driving time for most CMV drivers would not change, the FMCSA does not believe the options would have a significant impact on full employment or the creation of productive jobs. The FMCSA also does not believe that the proposal would have any significant impact on international competitiveness.

Prior Consultations with Elected Representatives of Any Affected State, Local, or Tribal Governments

This rule does not require action by State, local, or tribal governments. Therefore, no prior consultations with elected representatives of these governments were initiated.